TECHNICAL BULLETIN No. 188 SEPTEMBER, 1930

E&A

LIFE HISTORY AND HABITS OF THE PLUM CURCULIO IN THE GEORGIA PEACH BELT

BY

OLIVER I. SNAPP
Entomologist, Division of Deciduous Fruit Insects
Bureau of Entomology

IMP. INST. ENT.
— LIBRARY —
23 OCT 1930
SERIAL U/A 69
SEPARATE

UNITED STATES DEPARTMENT OF AGRICULTURE, WASHINGTON, D. C.

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - - - - Price 25 cents

Technical Bulletin No. 188 September, 1930

UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.

R

LIFE HISTORY AND HABITS OF THE PLUM CURCULIO[1] IN THE GEORGIA PEACH BELT

And.

By Oliver I. Snapp

Entomologist, Division of Deciduous Fruit Insects, Bureau of Entomology

X, 70
XI, 265, 412
XV, 159, 543
XV, 589

CONTENTS

	Page
Introduction	1
The Georgia peach belt and its climate	2
Methods and equipment	3
Studies of oviposition	3
Studies of incubation	3
Studies of the larval period	3
Larvae from peach drops	3
Studies of pupation	4
Emergence of adults	4
Studies of parasites	4
Studies of hibernation	4
Results of jarring	5
Studies of longevity	5
Feeding tests	5
The insectary	6
Weather records	6
Life history and habits of the plum curculio, as observed from 1921 to 1924, inclusive	6
Life history and habits of the plum curculio, as observed from 1921 to 1924, inclusive—Con.	
The egg	7
The larva	27
The larva, pupa, and adult in the soil	37
The adult	43
Time required for transformation from egg to adult	56
Occurrence of beetles in orchards throughout the seasons of 1921 to 1924, inclusive	60
Relation of temperature to appearance of plum curculios from hibernation	70
The relation of moisture and temperature to the development of the curculio	73
Parasites of the plum curculio in Georgia	77
Feeding tests with lead arsenate	80
Conotrachelus anaglypticus as a peach pest	88
Summary	90

INTRODUCTION

The plum curculio, *Conotrachelus nenuphar* Herbst, is the most important insect pest attacking the peach fruit in Georgia and presents one of the chief problems with which the peach growers of that State have to contend. Growers experienced an outbreak of this insect in uncontrollable numbers during the season of 1920, when it took a toll to the value of several million dollars. Only a small proportion of the peaches of the late varieties, which make up more than one-half of the acreage of peaches, could be marketed that year, the larvae of the curculio rendering the remainder unmerchantable. Much of the fruit that was shipped was unsalable when it arrived on the markets, because tiny larvae, hatched during harvest and too small to be detected when the fruit was packed, had become sizable in transit. This outbreak, unprecedented in the history of the insect, was largely due to carelessness and inadequate attempts at control in preceding years. The progeny of a number of ineffectively controlled generations of the curculio had been multiplying for several years, the result being the serious outbreak of 1920, when weather and other conditions were particularly favorable for the development of the insect. The seriousness of the situation led the Bureau of Entomology, at the urgent request of peach growers in Georgia, to undertake a thoroughgoing study of the life history of the plum curculio in the Georgia peach belt. These studies were conducted during the years 1921–1924 at Fort Valley, Ga., where a field laboratory had been established.[2]

---

[1] *Conotrachelus nenuphar* Herbst; order Coleoptera, family Curculionidae.

THE GEORGIA PEACH BELT AND ITS CLIMATE

One of the largest peach-growing districts in the United States is in central Georgia. This district surrounds Fort Valley, where the studies reported in this bulletin were conducted Within a radius of 100 miles of this town there are between 10,000,000 and 12,000,000 bearing and nonbearing peach trees in commercial orchards. The relief of the district varies from generally level, in the immediate vicinity of Fort Valley and to the southward, to rolling and hilly in the more northerly portions. The elevation ranges from 230 to 975 feet above sea level. The elevation where these studies were conducted is 526 feet.

The climate of this district is characterized by long, hot summers, during which the changes in temperature from day to day are very small, and by mild, brief winters. The normal annual mean temperature is about 66° F. High temperatures continue during June, July, and August, and occasionally September is the hottest month of the year. The average annual rainfall in the district is 48 inches.[3]

Climatic conditions greatly influence the development and severity of the curculio in the Southeast. Table 1, presenting for the four years of the study the mean temperature and the precipitation at Fort Valley for the period from February to October, inclusive, the season of activity of the curculio in Georgia, is therefore included to show a comparison of the weather conditions that prevailed each year, and for correlation with the development of the curculio.[4]

TABLE 1.—*Mean temperatures and precipitation, Fort Valley, Ga., February to October, 1921–1924*

Month	1921		1922		1923		1924	
	Mean temperature	Precipitation	Mean temperature	Precipitation	Mean temperature	Precipitation	Mean temperature	Precipitation
	°F.	*Inches*	*°F.*	*Inches*	*°F.*	*Inches*	*°F.*	*Inches*
February	51.4	2.77	56.9	4.67	49.4	3.87	47.3	5.15
March	64.9	1.10	58.0	9.73	57.8	7.51	52.6	3.37
April	64.4	3.10	68.0	2.63	64.4	3.27	63.5	4.79
May	71.0	3.80	72.5	5.90	69.5	9.71	69.8	3.94
June	81.2	2.91	80.0	3.74	78.3	5.99	80.4	4.93
July	80.0	8.24	80.6	5.95	79.7	2.64	80.0	6.18
August	79.8	4.31	78.8	4.28	80.8	5.00	82.6	1.39
September	82.4	1.80	77.2	2.63	77.0	2.83	71.7	11.25
October	64.8	2.21	66.5	2.91	65.3	.46	63.4	.81
Total precipitation for season		30.24		42.44		41.28		41.81
Mean temperature for season	71.1		70.9		68.9		67.9	

---

[2] The writer has been in charge of investigations of peach insects at the Fort Valley field laboratory since its establishment in November, 1920. The life-history records for 1921 were taken by E. R. Selkregg, assisted by C. H. Brannon. The writer was assisted in taking the records for the other years by H. J. Harris and J. A. Dodd in 1922, by H. S. Adair in 1923, and by B. S. Brown, jr., in 1924. In addition, the writer is greatly indebted to A. L. Quaintance, in charge of deciduous-fruit insect investigations of the Bureau of Entomology, for valuable suggestions and advice given throughout the investigations, and to C. H. Alden, of the field laboratory at Fort Valley, for much assistance.

[3] UNITED STATES DEPARTMENT OF AGRICULTURE, WEATHER BUREAU. SUMMARY OF THE CLIMATOLOGICAL DATA FOR THE UNITED STATES BY SECTIONS. CENTRAL AND EASTERN GEORGIA. U. S. Dept. Agr., Weather Bur. Bul. W, ed. 2, v. 3, illus. (Reprint Sec. 86.) 1926.

[4] UNITED STATES DEPARTMENT OF AGRICULTURE, WEATHER BUREAU. CLIMATOLOGICAL DATA, GEORGIA SECTION . . . February to October, 1921, 1922, 1923, and 1924. Atlanta, Ga. 1921–24.

METHODS AND EQUIPMENT

The procedure in these studies of the plum curculio in Georgia was very similar to that followed by Quaintance and Jenne [3] more than 15 years ago in their studies of this insect in several sections of the country. Much of the information resulting from the writer's studies is presented herewith in tables patterned after those of the investigators named.

STUDIES OF OVIPOSITION

Upon copulation, individual pairs of the insect were isolated and confined in separate jelly jars. These jars were supplied with egg-free peaches, which were renewed each day, the peaches removed being examined (pl. 1, A) with a binocular microscope to determine the number of eggs deposited by each female during the previous 24-hour period. The eggs can be located readily with the aid of a dissecting needle, used to throw up the excavation made in the peach by the female when the egg is deposited. Several inches of sand, which was kept damp, were placed in the bottom of each jar, and the jars were supplied daily with fresh peach-tree foliage for food and protection.

STUDIES OF INCUBATION

All of the peaches containing eggs deposited by a paired female during each 24-hour period were placed together in incubation jars. These peaches were then examined under the binocular each day or twice a day to determine the incubation period of each egg.

STUDIES OF THE LARVAL PERIOD

The peaches containing eggs, for which incubation records had been taken, were placed in wire trays, fitted within glass battery jars 6 by 8 inches in size for observation on the larval feeding period. As the larvae became full-grown and left the fruit, they fell through the wire tray to the bottom of the battery jar where they were collected daily, and records were made on the length of time spent in the larval stage.

LARVAE FROM PEACH DROPS

In order to obtain additional material for the life-history studies, peach "drops" were collected each year from under trees in the commercial orchards, for curculio larvae. These drops were placed in frames with wire bottoms, under which were slides consisting of cloth fastened to wooden frames. As the larvae reached maturity and left the fruit they fell through the wire bottom to the cloth slide below. The slides were pulled out each morning and the larvae counted and removed. These frames were also used in studies to determine the curculio infectation of peach drops from various orchards, and from the same orchard, from year to year, for purposes of comparison. Plate 1, B, shows one of the stands of frames used in the work dedescribed. This stand has four trays with wire bottoms. Under each tray is the shallow cloth slide from which the larvae are collected. The slides are 34 by 36 inches in size, and each section is 15½ inches high.

---

[3] QUAINTANCE, A. L., and JENNE, E. L. THE PLUM CURCULIO. U. S. Dept. Agr., Bur. Ent. Bul. 103, 250 p., illus. 1912.

STUDIES OF PUPATION

As an aid in studies of pupation special boxes were made (pl. 2, A), 8 by 10 inches in size and 3 inches deep, with wooden sides, removable glass bottoms sliding in grooves, and a hinged top of wire screen fastened by a hook. An inch or two of soil, placed in each box before the larvae were confined, was moistened each day. After the larvae were placed on top of the soil they would work their way down until the glass bottom was reached, and there make pupation cells. The boxes were lifted up and examined each day, the glass bottoms permitting observations on the development of the insect in the soil, and records were made of the time spent in the soil as larva, pupa, and adult. Marks were made on the glass for each larva under observation, so that individual records could be obtained. The adults would work their way up through the soil, but because of the wire screen they could not escape from the box. As the adults appeared above the soil in the boxes they were removed and recorded. Cloth pads were placed between the sides and the tops of the boxes to make the escape of adults impossible. Cotton was stuffed in the grooves which held the glass bottoms to prevent the escape of curculio larvae, and also to prevent the entrance of ants, which greatly interfere with studies of larval development and pupation in the soil by killing the larvae and pupae if they can get to them. Mice also will interfere with such studies if they can get to the trays into which larvae fall from the peach drops. The larvae will not go to the glass bottoms for pupation unless light is absolutely shut out by soil piled around the sides.

Studies were also made of the pupation of individual specimens kept in separate glass vials.

EMERGENCE OF ADULTS

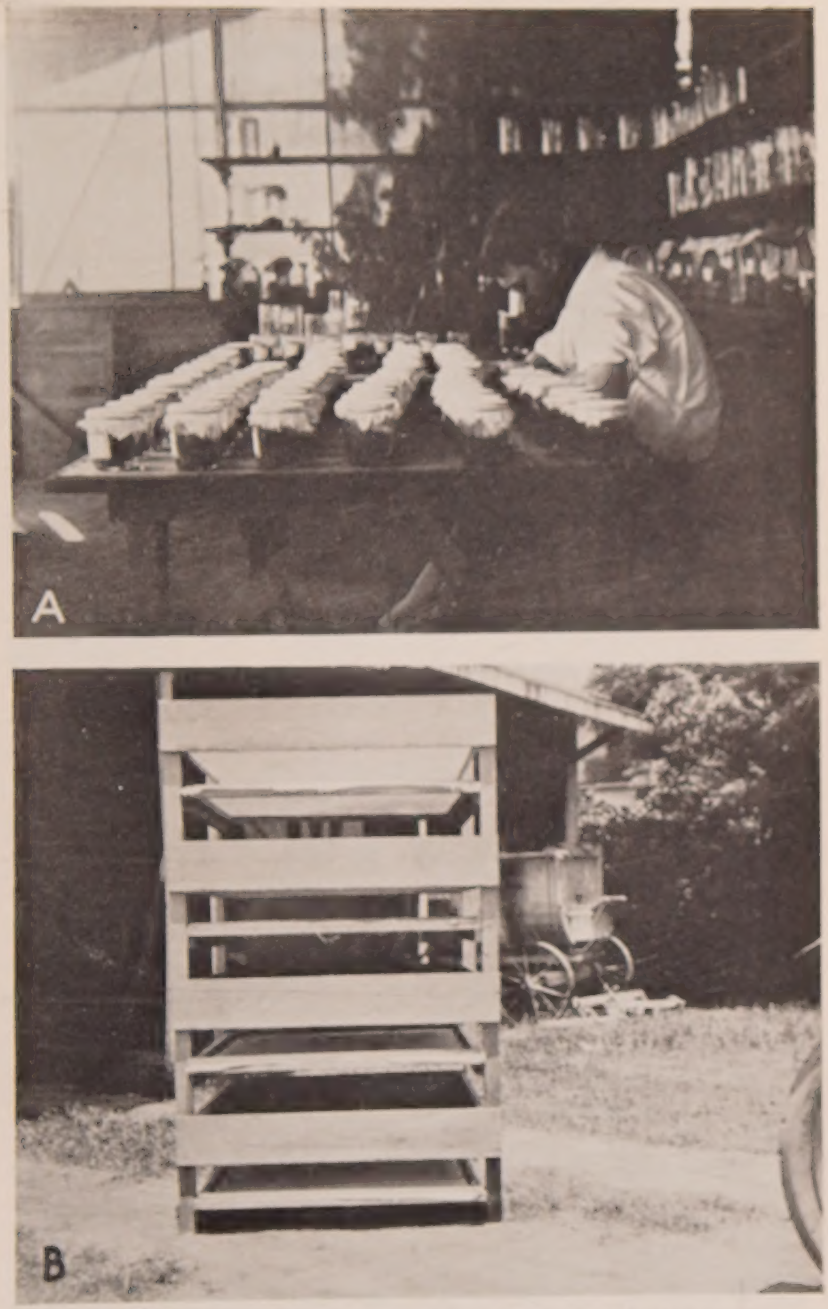
The boxes that were used in studying emergence of adults are shown in Plate 2, B. Each box was 12 by 15 inches in size and 9½ inches high and was nearly filled with soil, which was moistened from time to time. The tops of the boxes were of wire screen, and padding was used to make escape of adults impossible. Each box was of sufficient size for recording the emergence of adults from 1,000 larvae.

STUDIES OF PARASITES

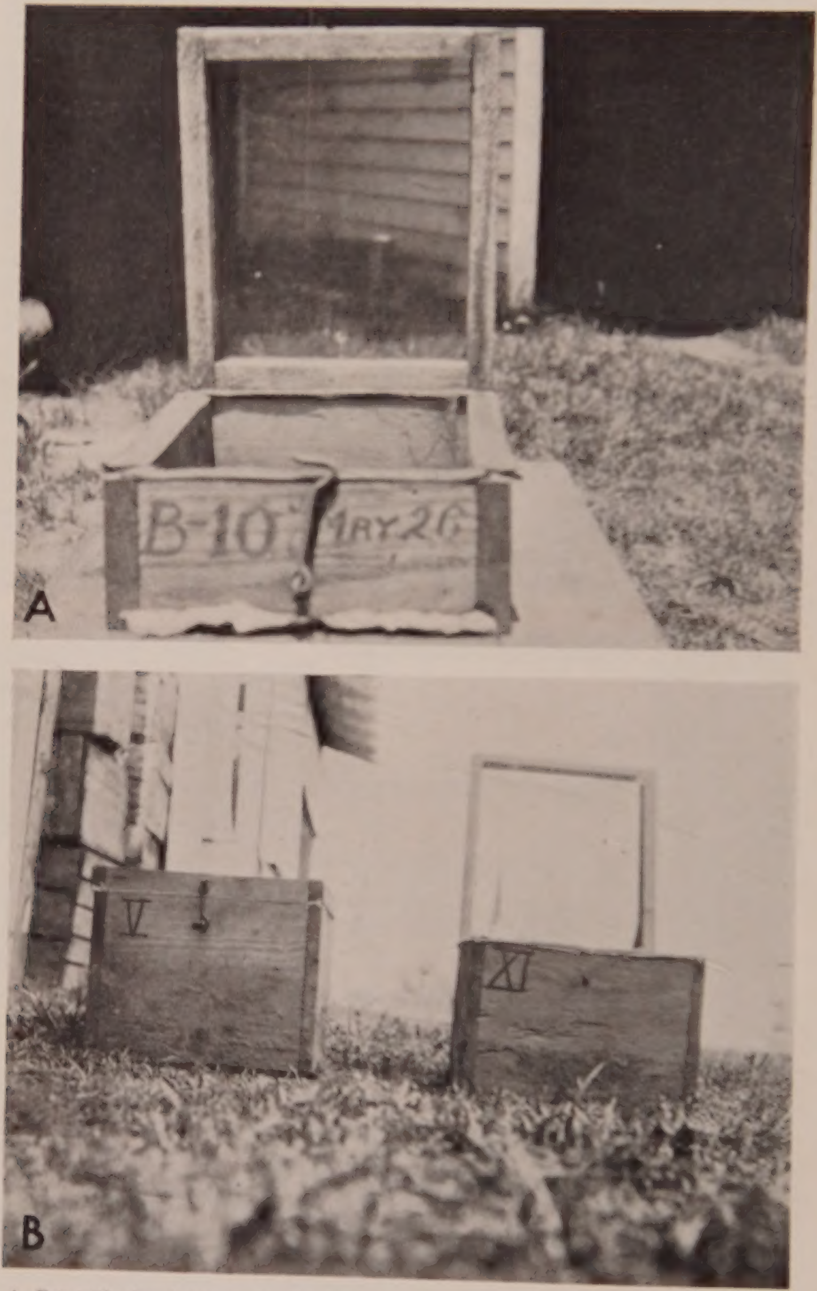
Studies of parasites were conducted each year in which these life-history studies were under way. Plate 3, A, shows a number of boxes that were found very satisfactory for this work, and Plate 3, B, shows one of the boxes in more detail. Records of parasites emerging from 1,000 curculio larvae could be taken from each box. The boxes were 12 by 15 inches in size and 9½ inches deep; their tops were covered with both wire screen and black cloth, and were padded so that curculio emergence records could be obtained as well as the data on parasites. A satisfactory shelter for the work of rearing parasites is also shown in Plate 3, A. The roof is canvas sheeting and can be rolled up from either side, as may be desired, to provide approximately natural weather conditions.

STUDIES OF HIBERNATION

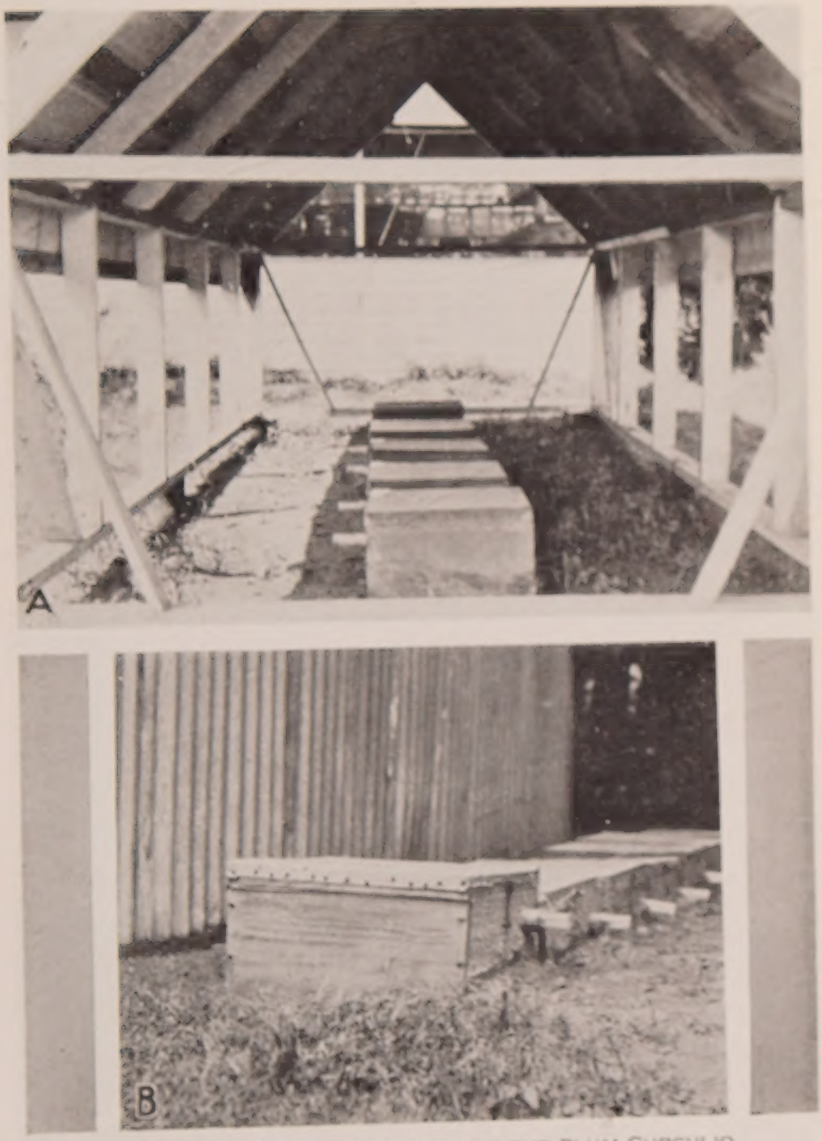
For the four years records were taken on the mortality of adult curculios during the winter, when supplied with different kinds of



A, Equipment used for making oviposition records of individual pairs of the plum curculio, Fort Valley, Ga.; B, stand of four trays with bottoms of wire mesh, and the cloth slides used with them, for determining the infestation of peach drops

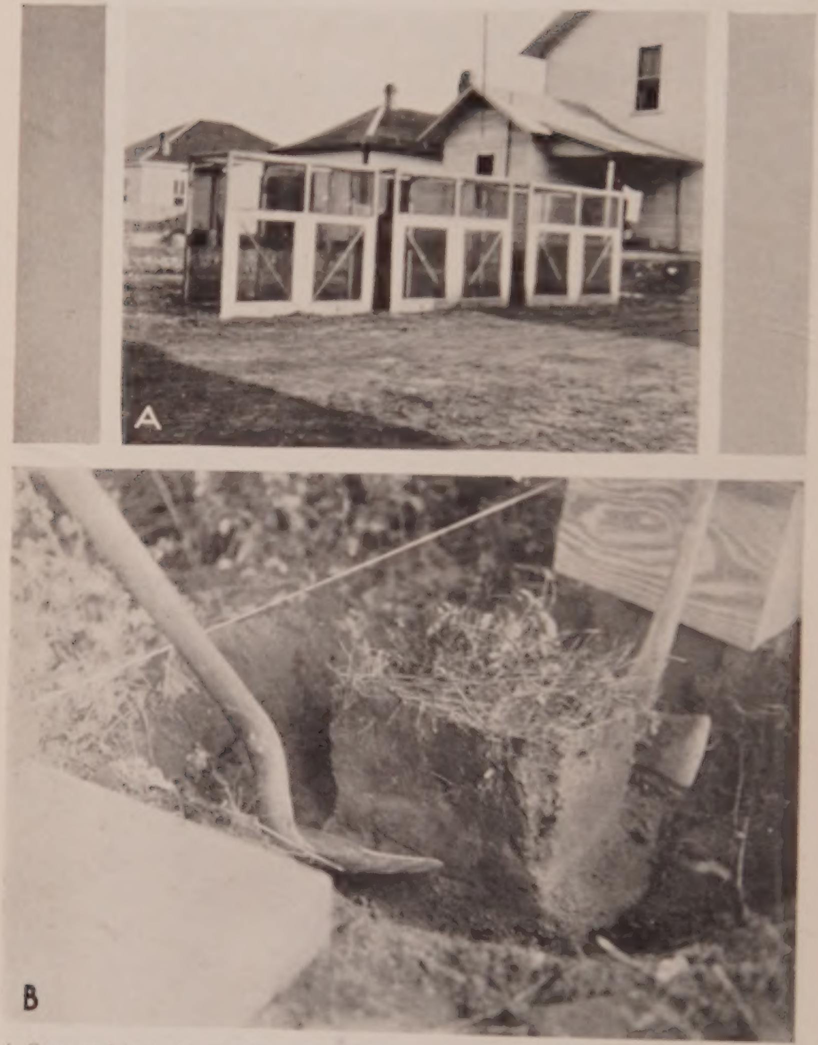


A, Box with glass bottom and wire-screen cover, used in studies of pupation of the plum curculio; B, boxes used in studies of emergence of adults of the plum curculio, Fort Valley, Ga.



BOXES FOR REARING PARASITES OF THE PLUM CURCULIO

A, Boxes in position in a special shelter under which the parasites were studied, Fort Valley, Ga.; B, parasite boxes shown in greater detail.

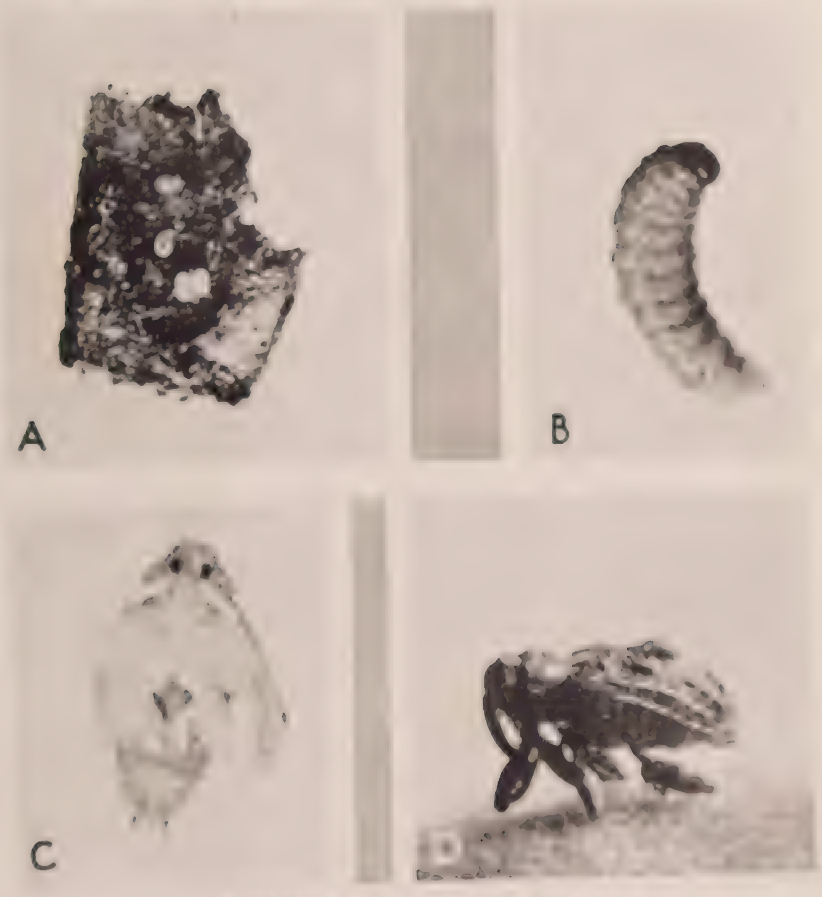


A, Cages used in studies of hibernation of the plum curculio, Fort Valley, Ga.; B, block of soil used in studies of hibernation

A
B

[illegible]

A, [illegible] in making climatological record. B, [illegible] crops in a commercial orchard


A
B
C
D

[illegible]

[illegible]

quarters for hibernation. The cages used for these studies were built in pairs, each cage being 3 feet square and 5 feet high (Pl. 4, A). A convenient door opened into each cage from the front. The cages were covered with wire screen and were constructed on a foundation, the boards of which went into the ground some 8 inches to prevent the escape of the beetles. The several kinds of hibernation quarters were placed on the ground, and the beetles were confined in them in the fall. As the beetles appeared on the screen in the spring they were collected and counted, and estimates were computed on the mortality of the beetles in hibernation for the four years. In the spring peach twigs containing open blossoms were placed in the cages to entice the beetles from hibernation. To ascertain if the beetles would go into the ground to hibernate, blocks of soil containing turf were cut (pl. 4, B), over which were placed boxes 12 by 8 by 9½ inches in size. Beetles were confined in the boxes, and in the winter sections of the soil blocks were examined for hibernating beetles.

RESULTS OF JARRING

During the four years that these studies were under way a number of peach trees were jarred regularly every few days for the collection of adult beetles. By counting these beetles data were acquired, to be correlated with data on the development of the insect in the insectary. Since the beetles, when jarred from the trees, feign death and fold their wings and fall, they were caught on "jarring frames," consisting of pieces of cotton sheeting 6 by 12 feet in size, fastened to wooden frames, some of which were provided with handles for convenience in carrying. Two frames, one having in its edge a notch 10 by 10 inches in size, to receive the trunk of the tree, were brought together under the tree preliminary to the jarring. The jarring was done by means of a pole which had on one end a wooden block padded with a piece of old automobile tire. The frames and poles are illustrated in Plate 5, A. The jarring was begun at sunrise, that it might be finished before the air became too warm, because in the warmer part of the day the beetles are more active when disturbed, and when jarred some fly away before reaching the sheets on the frames or crawl off the sheets before they can be collected. At intervals the beetles were collected from the sheets.

STUDIES OF LONGEVITY

In the course of these studies many records were taken on the longevity of adult beetles. Glass battery jars 6 by 8 inches in size were used. The bottoms of the jars were covered with sand, which was never allowed to become entirely dry, and their tops were covered with pieces of cloth, held in place by rubber bands. Peach foliage and fruit were supplied for food as needed, and conditions were made as natural as possible for the beetles confined in the jars. Adult beetles which had been reared in the insectary the previous year and had hibernated, and beetles captured during the year by jarring, were used in these longevity studies. Records of longevity were also made on the individual pairs of beetles confined in jelly glasses for studies of oviposition.

FEEDING TESTS

A number of tests of the effectiveness of insecticides were made with lead arsenate (as spray and as dust), nicotine dusts, etc., in the orchard and in the insectary. In the orchard, twigs containing fruit and foliage were treated with the insecticides by means of a hand sprayer or duster, and over each twig was placed a paper bag in which were confined a number of adult curculios. Daily examinations were then made for records of mortality. In the laboratory, peach twigs bearing foliage and fruit were sprayed or dusted with the insecticides to be tested and then placed in the battery jars in which adult curculios were confined, and records of mortality were made daily. In one series of tests paper bags containing adult beetles were placed over peach twigs bearing fruit and foliage on trees in an orchard sprayed and dusted by means of power outfits. In this series of tests the effectiveness of the insecticides in combating the curculio was tested when they were applied commercially under usual orchard conditions.

THE INSECTARY

The insectary (pl. 5, B), in which most of the studies of life history were conducted, was located on the laboratory grounds at Fort Valley, Ga. It measured 12 by 24 feet on the ground, 10 feet high at the eaves, and 12 feet at its highest point at the gable end. The construction permitted excellent circulation of air. The insectary was shaded by a large tree and was somewhat protected from the wind by near-by buildings, and by canvas curtains which could be lowered in case of storms. Wire screening rendered the structure insect-proof, and the equipment included convenient shelves, tables, and inclosure for handling parasites. Pupation boxes were arranged on the floor around the sides of the insectary. Near the insectary was the special structure for rearing parasites, shown in Plate 3, A.

WEATHER RECORDS

As meteorological observer at Fort Valley for the Weather Bureau, the writer has available a complete record for the years 1921 to 1925, inclusive, of weather conditions at the place where the investigations discussed were made. The influence of weather conditions on the life history and development of the plum curculio will be briefly touched upon in this bulletin. Maximum and minimum thermometers, a sling psychrometer, and hygrothermographs, kept in an instrument shelter (pl. 6, A) near the insectary, were regularly observed for data on temperature and humidity. The precipitation was measured by means of a standard Weather Bureau rain gage located near by. Records were also made of wind direction, character of day, and miscellaneous phenomena. All of these meteorological records are applicable to the conditions that existed both in the insectary and in the orchards at Fort Valley.

LIFE HISTORY AND HABITS OF THE PLUM CURCULIO, AS OBSERVED FROM 1921 TO 1924, INCLUSIVE

The life-history studies of the plum curculio were begun early in 1921, after preliminary arrangements had been made. A suitable laboratory had been established at Fort Valley in the fall of 1920. The work was started by jarring a block of peach trees every second morning to collect adult beetles as they appeared from winter hibernation. The records of these collections gave an insight into the activity of the insect in the orchards and were correlated with the developments taking place in the insectary. The beetles captured each time the trees were jarred were confined in a single cage. As pairs were seen in coition they were withdrawn and isolated in jelly tumblers to be observed for records of oviposition, as explained in the discussion of methods and equipment.

THE EGG

OVIPOSITION IN 1921

The records of oviposition in 1921 were based on the egg-laying performance of the females of 19 overwintered pairs, each pair being isolated in a separate jelly tumbler when they were noticed in coition in the cages containing massed beetles captured by jarring, and from 9 pairs of the first generation of adults hatched in 1921, which were also isolated when observed in coition. Each tumbler was supplied every day with peaches to be used both for oviposition and for food. Daily examinations of the fruit placed in the tumblers the day before were made for the discovery of eggs, the eggs being counted with the aid of a binocular microscope. Before depositing the egg the female excavates a suitable cavity with the jaws at the end of the snout, then she turns around and deposits the egg in the opening of the cavity, afterwards forcing it to the end of the cavity, and sometimes packing it with pulp. A slit is usually cut in front of the egg to protect it during the growth of the fruit. Sometimes the eggs are deposited around the edges of feeding punctures or places cut in the fruit. Some eggs, highly magnified, are shown in Plate 7, A.

Table 2 summarizes the record of the deposition of eggs during the season of 1921 by the females of 19 pairs of adult curculios that had overwintered.

TABLE 2.—*First-generation eggs laid in 1921 at Fort Valley, Ga., by the females of 19 pairs of overwintered plum curculios*

Pair No.	Date of isolation	Number of eggs laid week of—														Total
		Apr. 6 to 12	Apr. 13 to 19	Apr. 20 to 26	Apr. 27 to May 3	May 4 to 10	May 11 to 17	May 18 to 24	May 25 to 31	June 1 to 7	June 8 to 14	June 15 to 21	June 22 to 28	June 29 to July 5	July 6 to 12	
1	Apr. [illegible]			2	3											6
2	Apr. [illegible]	7	1	1												9
3	[illegible]	6	[illegible]													[illegible]
4	[illegible]		1	5	30	25	38	34	33	30	16	7	13			216
5	Apr. [illegible]					10	17	9	6	6	3					[illegible]
6	Apr. [illegible]					5	12	13	56	55	19					162
7	Apr. [illegible]					14	36	30	47	37	23	2	10	3	1	[illegible]
8	[illegible]					13	34	27	39	18	16	6		1		[illegible]
9	[illegible]					5	13	3	(¹)							35
10	Apr. [illegible]					2	12	15	1							37
11	[illegible]				4	6	2									12
12	[illegible]					6	14	11	13							[illegible]
13	May [illegible]					3	12	30	37	13	3					[illegible]
14	[illegible]					6	24	30	21	18	21	6		7		133
15	May [illegible]					1										1
16	May [illegible]					4	24	12								40
17	May [illegible]						5	6	28	31	16	8				97
18	May [illegible]							[illegible]	[illegible]							[illegible]
19	May [illegible]								24							24
Total		13	4	5	32	100	242	191	321	148	117	27	23	10	1	1,233
Average per female		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

---

¹ Adult lost.

These overwintered adults began to deposit first-generation eggs on April 11, reached maximum oviposition during the week of May 25 to 31, and ceased to oviposit by July 11. Oviposition during the stone hardening of the fruit was heavy that year. The heaviest oviposition of first-generation eggs during the season occurred between May 4 and June 14, the time during which the stones of the late varieties were hardening. These records prove that oviposition is not always diminished during the period of stone hardening and that there is no sudden cessation of egg laying at the beginning of this period. In all probability very few larvae hatching from eggs deposited during this period ever reach maturity. The large secretion of gum during the hardening of the pit, which drowns the larvae in their burrows, and the rapid growth of tissue in the fruit, which crushes them, are the chief causes of this mortality.

The absence of larvae in peaches during the time of stone hardening has sometimes been erroneously attributed to a cessation of oviposition. It is not believed that the beetles possess any inherent instinct to cease ovipositing at this time. Oviposition may be less then, in some seasons, when the females appear from hibernation earlier than usual as a result of abnormal weather, and their fecundity has largely ended. In such seasons the increased oviposition in ripening Hiley, Belle, and Elberta peaches is almost entirely caused by the new generation of adults. This was especially the case in 1922.

The average number of eggs deposited by hibernated females studied in 1921 was 69.74. The largest number deposited by a single ovipositing female was 214 and the smallest number was 1. The maximum number of eggs deposited by a single female in one day was 12. One female oviposited on 57 days during the season. The average number of first-generation eggs per female per day was 2.94.

The hibernated pairs which were used for oviposition studies were also observed for longevity. The average time between mating and the death of the males was 29.25 days and the females lived an average of 42 days after mating.

The record of the deposition of eggs of the second brood in the season of 1921 is summarized in Table 3. These eggs were deposited by the females of nine pairs of adult curculios, already mentioned, of the first generation hatched in that year, which began to deposit eggs on June 22, reached maximum oviposition in the week of July 13 to 19, and ceased oviposition for the season by August 16. During the three weeks from June 22 to July 12, eggs of both the first and second generations were being deposited in the insectary, the first by females which had hibernated, and the other by the nine females mentioned. The first-recorded egg of the second generation in 1921 was laid on June 14, when it was observed in a jar containing assembled adults of the first generation that had emerged between May 29 and June 2. The young larvae hatching from second-generation eggs first began to appear in the orchards during the harvest of Hiley peaches. The larvae in the fruit were then either very small or nearly full grown, a fact indicating that the last of the first-generation larvae were still in the peaches, and that larvae of the second generation were beginning to hatch. As the harvest advanced these small larvae increased in number. There was a distinct demarcation between the two generations of larvae in the orchards.

TABLE 3.—*Second-generation eggs laid in 1921 at Fort Valley, Ga., by the females of nine pairs of adults from emergence of the first generation*

Pair No.	Date of isolation	Number of eggs laid week of—								Total
		June 22 to 28	June 29 to July 5	July 6 to 12	July 13 to 19	July 20 to 26	July 27 to Aug. 2	Aug. 3 to 9	Aug. 10 to 16	
1	June 8	1								1
2	June 19				6	5				11
3	June 21			5	4	2		1	2	14
4	June 24	12	12	1	1					26
5	[illegible]				[illegible]					[illegible]
6	do		7	17	3					27
7	July 7			11	15					26
8	July 8			3	14	6		3	3	29
9	July 14				2	4				6
Total		13	19	37	53	17		4	5	156
Average per female		6.50	9.50	7.40	6.63	4.25		2.00	2.50	17.33

The female curculios of the first generation in 1921 were slow to begin ovipositing in the insectary. Some difficulty was experienced in getting peaches for oviposition during August and September. Methods for the studies of life history were being developed, and conditions for ovipositing by first-generation adults during the hot midsummer days were perhaps not the best. Had it been possible to get late fruit in 1921, and had more natural conditions for oviposition been supplied for the first-generation adults, the number of second-generation eggs deposited would undoubtedly have been greater and the period of oviposition longer. Although the new generation of beetles were slow to begin ovipositing in the insectary, the occurrence of young larvae of the second generation in the orchards was timed normally in relation to the appearance of the new beetles.

The average number of second-generation eggs deposited during the season of 1921 by females of the first generation was 17.33, but because of the conditions mentioned it does not represent the normal average. The maximum number of eggs deposited by a single female in one day was 7. The average number of second-generation eggs laid per female per day was 2.07. Observations of the individual pairs used for studies of oviposition showed that the males of the first generation lived an average of 18.25 days and the females an average of 27.43 days. Had the beetles lived under more natural conditions, the longevity of both males and females would have been greater and undoubtedly a number would have gone into hibernation at the end of the season.

OVIPOSITION IN 1922

The records of oviposition in 1922 were based on the performance of the females of 30 pairs which had hibernated during the winter of 1921–22, 11 pairs of the first generation of adults which were reared in the insectary in 1922, and those of 15 pairs collected by jarring in May and June. These pairs were isolated when they were observed in copulation and confined in jelly tumblers with sand, kept moist, in the bottom. Peaches were supplied daily for food and to oviposit in. The eggs from each pair were counted daily with the aid of a binocular microscope. Table 4 summarizes the record of the deposition of eggs.

These adults began to deposit eggs on April 7, reached maximum oviposition during the week of April 13 to 19, and completed oviposition by May 31. The first egg was noticed in the orchards on April 3. Oviposition was not heavy during the stone-hardening period. The heaviest oviposition occurred during April, and the fecundity of the overwintered females was becoming exhausted by the time the peach stones were hardening.

TABLE 4.—*First-[illegible] [illegible] laid in [illegible] at Fort Valley, Ga., by the females of 50 pairs of overwintered plum curculios*

Pair No.	[illegible]	[illegible]								Total
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
1	Mar. [illegible]									[illegible]
2	do.									[illegible]
3	Mar. [illegible]									[illegible]
4	do.	5	2							[illegible]
5	do.		[illegible]							[illegible]
6	do.									[illegible]
7	Mar. 21	11	8	1	[illegible]	2	[illegible]	[illegible]		[illegible]
8	do.									[illegible]
9	Mar. 24									[illegible]
10	do.									[illegible]
11	do.	8	12		[illegible]	[illegible]				[illegible]
12	do.	8	2							[illegible]
13	do.	6	3							[illegible]
14	Mar. 25	4								[illegible]
15	do.	9	9							[illegible]
16	do.	6	7	2						[illegible]
17	do.									[illegible]
18	do.	3	21	2	3					[illegible]
19	do.		6		2					[illegible]
20	do.	2								[illegible]
21	do.	3								[illegible]
22	Mar. 27	3	3	1	2		1	[illegible]		[illegible]
23	Mar. 28	6	1	1						[illegible]
24	do.	7	1							[illegible]
25	Mar. 29									[illegible]
26	do.	4	1	3	4					[illegible]
27	do.	3	5							[illegible]
28	do.									[illegible]
29	Mar. 30	3	3	2	1	[illegible]	7	6		[illegible]
30	do.		5	2						[illegible]
31	do.		1							[illegible]
32	do.									[illegible]
33	Mar. 31	11	5	2	2		5	5	[illegible]	[illegible]
34	do.									[illegible]
35	do.	5								[illegible]
36	Apr. 1	7	19	2	7	[illegible]	5	4		[illegible]
37	Apr. 4	2	15		1			2	[illegible]	[illegible]
38	do.	1								[illegible]
39	do.	9	13	3	6					[illegible]
40	do.	3	2	1						[illegible]
41	do.	4	7		9					[illegible]
42	do.	4	17	1						[illegible]
43	Apr. 5		1							[illegible]
44	Apr. 8	1								[illegible]
45	Apr. 9	5	12	1	1					[illegible]
46	Apr. [illegible]		5							[illegible]
47	do.	4	2							[illegible]
48	Apr. 11		3							[illegible]
49	do.									[illegible]
50	Apr. [illegible]									[illegible]
Total		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Average per female		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4	[illegible]	[illegible]

The average number of first-generation eggs deposited in the season by hibernated laying females was 14.58. The observations in this series were made every second or third day, and therefore the actual number of days on which eggs were laid, the maximum number of eggs in one day, and the average number of eggs per day can not be given. Undoubtedly during this series the sand in the containers was kept too moist for maximum oviposition. Fungus was often found growing in the jars. In all probability these unnatural conditions affected the oviposition of the hibernated females in 1922, causing the number of eggs recorded to be much smaller than normal. Observations on the hibernated pairs used for oviposition studies in 1922 showed that the average number of days between mating and the death of males was 27.15, whereas the females lived an average of 38.08 days after mating.

Table 5 summarizes the record of the deposition of eggs of the second generation during the season of 1922 by the females of 11 pairs of first-generation curculios reared in the insectary. These females began to deposit eggs on June 24, reached maximum oviposition during the week of July 20 to 26, and completed oviposition for the season on September 15. On September 22 the pairs or individuals remaining alive were placed in hibernation. The first egg of the second generation recorded in 1922 was observed on June 14 in a jar containing assembled first-generation adults that were reared in the insectary. In all probability oviposition of second-generation eggs in the field occurred at about that time. There was perhaps very little overlapping of depositions of eggs of the first and second generations during the season of 1922.

TABLE 5.—*Second-generation eggs laid in 1922 at Fort Valley, Ga., by the females of 11 pairs of adult plum curculios of the first generation reared in the insectary*

Pair No.	Number of eggs [1] laid week of—													Total
	June 22 to 28	June 29 to July 5	July 6 to 12	July 13 to 19	July 20 to 26	July 27 to Aug. 2	Aug. 3 to 9	Aug. 10 to 16	Aug. 17 to 23	Aug. 24 to 30	Aug. 31 to Sept. 6	Sept. 7 to 13	Sept. 14 to 20	
1	0	0	0	0	27	35	36	12	3	0	0	0	0	113
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	13	0	......	......	......	......	......	......	......	......	......	......	......	13
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	1	8	21	0	0	......	......	......	......	......	......	......	......	30
6	0	0	0	0	0	......	......	......	......	......	......	......	......	0
7	0	15	11	12	22	24	36	18	3	0	0	0	0	141
8	0	6	8	8	0	0	0	0	0	0	0	0	0	22
9	......	4	21	22	32	7	0	0	0	0	0	0	0	86
10	......	0	1	0	0	0	0	1	40	12	1	11	3	69
11			12	7	24	10	2	0	0	0	0	......	......	55
Total	14	33	74	49	105	76	74	31	46	12	1	11	3	529
Average per female	7	8.25	12.33	12.25	26.25	19	24.67	10.33	15.33	12	1	11	3	48.09

[1] [illegible]

The average number of eggs of the second generation deposited by each laying first-generation female in 1922 was 66.12, considerably more than in 1921, when conditions for oviposition in captivity were poor. The maximum number of second-generation eggs deposited by a single female in one day was 8. One second-generation female deposited eggs on 40 days during the season. The average number of second-generation eggs per laying female per day was 2.02. The males that did not enter hibernation lived an average of 61.67 days, and the females an average of 60.25 days.

In 1922 similar records were made for the females of 15 pairs of curculios that were collected by jarring between May 25 and June 17. These beetles, therefore, either hibernated during the winter of 1921-22 or were adults of the first generation of 1922, in all probability the latter. Although it can not be definitely stated whether the eggs deposited were of the first or second generation, the records would indicate that they were eggs of the second generation. Table 6 summarizes the record of the deposition of these eggs.

TABLE 6.—*Eggs laid at Fort Valley, Ga., by the females of 15 pairs of adult plum curculios collected by jarring between May 25 and June 17, 1922*

Pair No.	Date of collection	Date of isolation	Number of eggs laid week of—										Total
			June 8 to 14	June 15 to 21	June 22 to 28	June 29 to July 5	July 6 to 12	July 13 to 19	July 20 to 26	July 27 to Aug. 2	Aug. 3 to 9	Aug. 10 to 16	
1	May 30	June 9	4	6	2	2	8	18	24	10	[illegible]	[illegible]	[illegible]
2	June 13	June 13	......	2	1	4	6	2	0	......	......	......	[illegible]
3	do	do	......	1	1	0	12	25	23	3	[illegible]	[illegible]	[illegible]
4	June 3	June 15	......	2	2	0	......	......	......	......	......	......	[illegible]
5	June 15	do	......	3	9	2	11	23	16	0	[illegible]	[illegible]	[illegible]
6	do	June 16	......	0	4	9	7	......	......	......	......	......	[illegible]
7	June 3	June 17	......	14	21	13	11	5	4	12	......	......	[illegible]
8	June 8	June 19	......	1	2	2	1	1	0	0	......	......	[illegible]
9	June 9	June 20	......	......	0	0	0	0	2	0	......	......	[illegible]
10	May 25	June 21	......	......	15	9	9	6	9	5	......	......	[illegible]
11	June 6	June 22	......	......	6	8	13	10	29	13	......	......	[illegible]
12	[illegible]	[illegible]	......	......	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
13	do	June 28	......	......	......	0	0	0	0	1	0	[illegible]	[illegible]
14	[illegible]	[illegible]	......	......	......	[illegible]	......	......	......	......	......	......	[illegible]
15	June 3	June 30	......	......	......	3	19	22	17	1	......	......	[illegible]
Total			4	29	63	55	98	112	125	65	6	[illegible]	[illegible]
Average per female			4	4.14	6.3	5	8.91	12.44	13.89	6.43	3	1	[illegible]

These beetles began to oviposit on June 12, reached maximum oviposition during the week of July 20 to 26, and completed oviposition by August 15. The average number of eggs deposited by each female was 55.87. The maximum number of eggs deposited by a single female in one day was 10. One female deposited eggs on each of 36 days. The average number of eggs per female per day was 2. Records of longevity showed that the males lived an average of 60.46 days after the date of collection in the field and the females lived an average of 64.46 days.

OVIPOSITION IN 1923

In 1923 records were made from 63 individual pairs which had been reared in the insectary in 1922 and which had passed the winter. These were isolated in separate jelly tumblers when they were noticed in copulation. There were no records of eggs of the second generation laid by adults in 1925, as this was the one year of the four comprising the period of these studies in which only one full generation occurred. Climatic conditions prevented a full second generation in 1925, both in the orchards and in the insectary. A number of first-generation adults copulated in the summer of 1925 and were isolated as usual in jelly tumblers, but none of them attempted to oviposit.

Table 7 summarizes the record of the deposition of first-generation eggs during the season of 1923 by the females of 47 pairs of plum curculios that had passed through the winter. These beetles were reared in the insectary and were of the first generation of 1922. On account of the large number of individual pairs that were carried for oviposition records in 1923, the eggs deposited by the 47 females were counted at the end of every three days instead of daily.

TABLE 7.—*First-generation eggs laid in 1923 at Fort Valley, Ga., by the females of 47 pairs of plum curculios of the first generation of 1922, reared in the insectary in 1922 and overwintered*

Pair No.	[illegible]	Number of eggs laid week of—	Total
[illegible]	[illegible]	[illegible]	[illegible]

[illegible]	[illegible]		[illegible]	1	6	[illegible]	13		[illegible]	6	17	3	10	[illegible]	2	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	2	3	[illegible]	7	12	[illegible]	2	5					[illegible]		[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	5	6	[illegible]	19		[illegible]	1	17	4	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			[illegible]	8	16	[illegible]	34	[illegible]	[illegible]	14	11	2	0	4	10	[illegible]	11	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			[illegible]	3	15	[illegible]	17	19	[illegible]	8	30	0	2	4	2	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			[illegible]	0	5	[illegible]	5	4	[illegible]	4	6	0	0	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	0	12	[illegible]	13	[illegible]	[illegible]	2	0	4	11	[illegible]	6	[illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	2	45	[illegible]	15	[illegible]	[illegible]	11	33	4	5	[illegible]	5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total		[illegible]	[illegible]	212	417	[illegible]	498	[illegible]	[illegible]	253	343	100	115	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Averages per female		[illegible]	[illegible]	5.73	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4.74	5.48	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

The females of the first generation of 1922 began to deposit eggs of the first generation of 1923 on April 9, reached maximum oviposition during the week of May 18 to 24, and ceased to oviposit by August 28. Individuals, or pairs, remaining alive on August 30 were placed in hibernation. Oviposition during May and early in June, 1923, when the peach stones were hardening, was heavy, as shown in the table. However, as explained in the discussion of the oviposition records for 1921, very few of the larvae that hatch from eggs deposited during this period ever reach maturity.

The average number of first-generation eggs deposited during the season of 1923 by females of the first generation of 1922 was 80.77. As the observations for oviposition were made on every third day, it is not possible to give the actual number of days on which eggs were laid by these females, or the maximum number deposited in any one day, or the average number per female per day.

The first curculio egg to be found in the field in 1923 was observed on April 5 in a wild plum. No eggs were found in peaches in the field until April 12, although some few were probably deposited before that date, as deposition in peaches began in the insectary on April 8.

Table 8 summarizes the record of eggs laid by the females of 8 pairs of plum curculios that had passed through the winter of 1922–23. These beetles were of the first generation of 1922 and were reared in the insectary. Their eggs were counted daily.

TABLE 8.—*First-generation eggs laid in 1923 at Fort Valley, Ga., by the females of eight pairs of plum curculios of the first generation of 1922, reared in the insectary and overwintered*

Pair No.	[illegible]	Number of eggs laid week of—									
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Average per female		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Pair No.	[illegible]	Number of eggs laid week of—								Total
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Average per female		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

These females began to deposit eggs on April 12, 1923, and reached maximum oviposition during the week of April 27 to May 3, although oviposition was heavy through May and early in June. They ceased to oviposit by August 3. The average number of first-generation eggs deposited by them was 188.83. The maximum number deposited in one day by one individual was 11. One female deposited eggs on each of 93 days. The average number of eggs per female per day was 3.03.

Table 9 summarizes the record of the deposition of first-generation eggs during the season of 1923 by the females of eight pairs of adults of the second generation of 1922, reared in the insectary and overwintered. The eggs were counted daily.

TABLE 9.—*Eggs of the first generation laid in 1923 by the females of eight pairs of plum curculios of the second generation of 1922, reared in the insectary and overwintered*

Pair No.	Date of emergence	Number of eggs laid week of—									
		Apr. 6 to 12	Apr. 13 to 19	Apr. 20 to 26	Apr. 27 to May 3	May 4 to 10	May 11 to 17	May 18 to 24	May 25 to 31	June 1 to 7	June 8 to 14
1	Mar. 16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	Mar. 24	7	[illegible]	9	8	13	7	7	1	0	7
3	do	10	8	37	46	35	30	43	30	43	30
4	Mar. 30	0	0	0	0	0	1				
9	Apr. 10	0	4	39	36	16	66	21			
10	Apr. 17	......	0	6	10	5	30	16			
11	Apr. 19	......	......	1	19	12	21	13	19	31	28
12	Apr. 25	......	......	0	8	5	16	25	15	10	3
Total	....	18	37	107	169	110	218	158	99	108	62
Average per female		6	9.25	17.83	24.14	15.71	27.25	22.57	19.8	21.6	12.4

Pair No.	Date of emergence	Number of eggs laid week of—								
		June 15 to 21	June 22 to 28	June 29 to July 5	July 6 to 12	July 13 to 19	July 20 to 26	July 27 to Aug. 2	Aug. 3 to 9	Total
1	Mar. 16	17	12	3	12	5				316
2	Mar. 24	5	4	1	1	2	4	0	1	85
3	do.	43	42	40	27	8	1	23	13	516
4	Mar. 30	......	......	......	......	......	......		...	1
9	Apr. 10	......							...	152
10	Apr. 17	......	......	......	......	......	......			66
11	Apr. 19	31	27	35	33	34	16	11		359
12	Apr. 25	38	31	25	25	20	24	40	13	302
Total	....	134	116	104	98	69	45	74	[illegible]	1,771
Average per female		26.8	23.2	20.8	19.6	13.8	11.25	24.67	[illegible]	221.38

The second-generation females of 1922 began to deposit first-generation eggs in 1923 on April 8, reached maximum oviposition during the week of May 11 to 17, the same week as did the first-generation females of 1922, and ceased to oviposit by August 8. Oviposition was heavy during the period of stone hardening, as was the case with oviposition by females of the first generation of 1922. The average number of eggs deposited per female was 221.38. The largest number deposited by a single female was 516, which incidentally was the highest oviposition recorded for any individual during the four years. This female deposited a maximum number of 14 eggs in one day, and she oviposited on 101 days during the season. The average number of eggs per female per day was 1.34. Oviposition during the season of 1923 by females of the second generation of the preceding year was heavier than that by females of the first generation, owing to the oviposition begun by first-generation females in the year in which they were reared.

In 1923 an attempt was made to record the oviposition of females for which oviposition records had been made in 1922. Only two pairs and one female of a third pair survived the winter of 1922–23. The female of one of these pairs failed to deposit any eggs in 1923, and the female of the other pair and the individual female deposited only one egg each. The single individual died on May 29, and the two pairs died in hibernation in the winter of 1923–24.

As has been remarked, there was no second generation of any consequence of the plum curculio in Georgia in 1923. Fifty-one pairs of adults of the first generation copulated and were isolated in separate jelly tumblers, but none of them deposited eggs or showed signs of oviposition. They fed considerably and were normal in every other respect. A single egg was found on August 2 in a peach in one of the tumblers, but in all probability this egg was deposited in the field before the peach was brought in, by a female which had overwintered, and was overlooked when the eggs were being cut from the peaches to be placed in the tumblers.

A few eggs of the second generation were found in a large cage in which were kept together 149 adults of the first generation of 1923 that were reared in the insectary. Of these, 75 emerged on June 12 and 74 on June 13. By females of the earlier lot 5 eggs were laid on August 3, 1 on August 5, 4 on August 22, and 3 on August 27, a total of 13. By females of the later lot 45 eggs were laid in all, 10 on August 4, and the others on 13 later dates, ending with the deposition of 1 egg on August 30. The maximum number of eggs laid on any one day after August 4 was 7.

OVIPOSITION IN 1924

The records of oviposition in 1924 were based on the performance of the females of 27 pairs of adults which had hibernated during the winter of 1923–24 and laid eggs of the first generation in 1924, and 7 pairs of the first generation of adults in 1924, which laid eggs of the second generation of that year. All of the beetles used for oviposition in 1924 were reared in the insectary. They were isolated in jelly tumblers when they were noticed in cotton. All eggs laid in 1924 were counted daily.

Table 10 summarizes the record of the deposition of first-generation eggs during the season of 1924 by the females of 27 pairs of adult curculios of the first generation of 1923. These began to deposit eggs on April 10, reached maximum oviposition during the week of April 27 to May 3, and completed oviposition by July 15. On April 9 the first curculio egg was found in the orchard in 1924. A study of the table shows that considerable oviposition took place in 1924 during the stone-hardening period.

TABLE 10.—*Eggs of the first generation, laid in 1924 by the females of 27 pairs of plum curculios of the first generation of 1923, which had passed in the insectary and overwintered*

Pair No.	Date of isolation	Apr. 6 to 12	Apr. 13 to 19	Apr. 20 to 26	Apr. 27 to May 3	May 4 to 10	May 11 to 17	May 18 to 24	May 25 to 31	June 1 to 7	June 8 to 14	June 15 to 21	June 22 to 28	June 29 to July 5	July 6 to 12	July 13 to 19	Total
		Number of eggs laid week of—															
52	Mar. 26	2	3	7	16	13	8	3	3								55
53	do	1	2	9	3	9	4	3	1	0	2						34
54	Apr. 16		1	2	3												6
55	Mar. 31	2	3	10	25	20	5	12	5	17	7	11					117
56	do	1	1														2
57	do	0	5	8													13
58	Apr. 16		3	12	14	7	7	24	16	6	24	12	9	12	3	1	[illegible]
59	Apr. 2	0	1														1
60	do	0	0	14	11	14	19	15									73
63	Apr. 4	1	0	5													6
64	do	0	0	7	8	13	1	0	1								30
65	Apr. 7	0	3														3
67	Apr. 10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]								[illegible]
68	do	0	1	6	17	18	9	8	14	8	6	16					103
69	do	0	1	0	0	3											4
70	do	0	2	3	11	7	12	19	10	0	1	0	1	7	1		74
71	do	0	3	4													7
72	do	0	2	7													9
74	Apr. 19		0	1	6	7	5										19
80	Apr. 22			4	2	3	0	3									12
[illegible]	[illegible]				[illegible]	[illegible]											[illegible]
84	[illegible]				[illegible]	[illegible]											[illegible]
[illegible]	[illegible]				[illegible]	[illegible]											[illegible]
[illegible]	[illegible]				[illegible]	[illegible]											[illegible]
88	May 10						14	22	24	17	27	10					114
89	do						4										4
90	do						[illegible]										[illegible]
Total		7	42	112	148	131	111	122	83	64	67	36	10	14	6	1	906
Average per female		1.4	2.63	6.22	9.25	8.73	7.40	13.9	9.22	8.0	11.17	12.0	5	7	2	1	33.56

The average number of first-generation eggs deposited per female during the season of 1924 was 33.56. The maximum number of eggs deposited by a single female in one day was 9. One female oviposited on each of 60 days of the season. The average number of eggs per female per day was 1.79. The hibernated beetles did not oviposit as heavily in 1924 as they did in 1923, perhaps because plums were used in getting some of the oviposition records in 1923. The curculio prefers a smooth-skinned stone fruit for oviposition.

Table 11 summarizes the record of the deposition of second-generation eggs during the season of 1924 by the females of seven pairs of beetles of the first generation of that year. The females began to lay these eggs on July 7, reached maximum oviposition in the week of August 3 to 9, and ceased oviposition for the season on October 18. Of course oviposition did not take place at that late date in the commercial orchards, as the peach harvest had long been over. The average number of eggs deposited per female was 40. The individual ovipositing pairs in the insectary were supplied with late peaches from a small home orchard.

TABLE 11.—*Eggs of the second generation, laid in 1924, by the females of seven pairs of plum curculios of the first generation of that year, reared in the insectary*

Pair No.	[illegible]	Number of eggs laid week of—															
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Total
2	June 20	1															1
11	July 5	9	6	14	8	29	28	28									122
18	July 11	0	3	4													7
22	July 19			16	7	15	6										44
28	July 24			0	1												1
34	Aug. 2					18	15	4	0	1							38
[illegible]	Aug. [illegible]									[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Average per female			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

As shown in Tables 10 and 11, there was practically no overlapping in the deposition of first-generation and second-generation eggs in 1924, as the first generation of adults did not begin to oviposit until the deposition by beetles that had passed through the winter of 1923–24 had practically ended. Deposition of second-generation eggs in jars containing massed beetles of the first generation of 1924 began between July 8 and July 12, and the oviposition in these jars was heavy by July 16.

Apples were tried for oviposition at one time in 1924, when peaches were scarce, but the curculios did not oviposit in them as readily as they did in plums and peaches. Apples were also used at times in other years. Peaches were used almost entirely for oviposition in 1924. Plums were used for oviposition, especially early in the season. The plum curculio apparently prefers plums to other fruit for oviposition, probably because of the smooth skin and the texture of the meat of the plum.

The average number of second-generation eggs deposited during the 1924 season by females of the first generation was 49. The maximum number of eggs deposited by one female in one day was 7. These females did not deposit eggs over a very long period, the greatest number of days upon which any of them oviposited being 28. The average number of eggs per female per day was 2.53.

OVIPOSITION DURING THE FOUR YEARS

In Table 12 are brought together the combined weekly egg-laying records of all beetles of the plum curculio for each of the four years, during which oviposition records of 10,940 eggs were made.

Table 12.—[illegible]

Year	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	First	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Second	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	First	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Second	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	First	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	First	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Second	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total	First	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Second	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	All generations	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

The maximum number of eggs deposited by a single individual during the four years were laid in 1923, when one female of the second generation of 1922 that had lived through the winter of 1922-23 deposited 616 eggs. The maximum number of eggs by an individual of the first generation were also laid in 1923, when one individual of the first generation of 1922 deposited 280 eggs. The average number of eggs deposited per individual by the various groups ranged from 13.3 to 221.38. The average number of first-generation eggs deposited per individual per season during the four years was 64.64, the average number of second-generation eggs was 40.21, and the average per individual per season for all eggs was 59.14.

The percentages of eggs deposited by the end of the second, fourth, sixth, and eighth weeks after isolation of the parents, and during the ninth and all later weeks are given in Table 13 for all of the eggs of the first generation, those of the second, and those laid in 1923 and classed as of either the first or second, but which in all probability are of the second.

TABLE 13.—*Percentage of eggs of the plum curculio deposited in given periods of the egg-laying season, Fort Valley, Ga., 1921–1924*

Generation	Percentage of eggs deposited—				
	By end of second week	By end of fourth week	By end of sixth week	By end of eighth week	During ninth and later weeks
First	6.3	[illegible]	[illegible]	[illegible]	[illegible]
Second	31.4	[illegible]	[illegible]	97.9	[illegible]
First or second	[illegible]	[illegible]	[illegible]	[illegible]	

The period over which first-generation eggs are deposited is more extended than the period of deposition of second-generation eggs. Only 6.3 per cent of the total first-generation eggs were deposited during the first two weeks after copulation, whereas 31.4 per cent of the total second-generation eggs were deposited during a like period. Over half of the total second-generation eggs had been deposited by the end of the fourth week, whereas not quite one-fourth of the total first-generation eggs had been deposited at the end of that period. At the end of the eighth week, 97.9 per cent of the total second-generation eggs had been deposited, whereas at the end of the eighth week in the case of overwintered adults only 61 per cent of the eggs of the first generation had been laid.

Although the generation of the eggs referred to in Table 12 as either first or second can not be definitely determined, it is highly probable that they are second-generation eggs, as the records of oviposition seem to indicate, and they were deposited by bright, new-looking adults that were collected by jarring peach trees at the time first-generation beetles were emerging from the soil in 1922.

INCUBATION IN 1921

The fruit containing eggs that were deposited on any one day was placed in a single incubation jar. On the second or third day after deposition, depending on the temperature, and on each day thereafter, each egg was examined to determine the date of hatching. In examining eggs for incubation records the slit in the fruit above the egg was raised with a dissecting needle under a binocular microscope. Table 14 gives the incubation periods for 270 eggs of the first generation during the season of 1921.

TABLE 14.—*Length of incubation period of 270 first-generation eggs of the plum curculio, Fort Valley, Ga., 1921*

Time of deposition	Eggs	Egg days	Average incubation period
	Number	*Number*	*Days*
May	115	654	5.69
June	100	333	3.33
July 2 to 12	55	183	3.33
Total or average	270	1,170	4.33

No incubation records are available for April, 1921; however, the period would have been at least as long as if not longer than for May. On account of higher temperatures the incubation period of plum curculio eggs in Georgia is much shorter from June to August than it is before or after that time. The average time for first-generation eggs to hatch was 5.69 days in May and 3.33 days in June and July. The average period for the season was 4.33 days.

INCUBATION IN 1922

During the season of 1922 the eggs were examined twice in each 24 hours to obtain the hatching dates. However, hatchings were recorded at only one examination in each 24-hour period, therefore the incubation periods represented by fractions of days are omitted from the tables. Incubation records were made during the season on [illegible] eggs of the first generation (Table 15) and 89 eggs of the second generation.

TABLE 15.—*Length of incubation period of [illegible] first-generation eggs of the plum curculio, Fort Valley, Ga., 1922*

Date of deposition	Number of eggs	Number of eggs hatching in specified periods (in days)								
		2	3	4	5	6	7	8	9	[illegible]
Apr. [illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
Apr. [illegible]	[illegible]			[illegible]						[illegible]
Apr. [illegible]	[illegible]							[illegible]	[illegible]	[illegible]
Apr. [illegible]	[illegible]					[illegible]				[illegible]
Apr. [illegible]	[illegible]	[illegible]			[illegible]					[illegible]
Apr. [illegible]	[illegible]					[illegible]		[illegible]		[illegible]
Total	[illegible]									[illegible]
May [illegible]	[illegible]		[illegible]	[illegible]	[illegible]					[illegible]
May [illegible]	[illegible]		[illegible]		[illegible]					[illegible]
May [illegible]	[illegible]	[illegible]			[illegible]					[illegible]
May [illegible]	[illegible]			[illegible]						[illegible]
May [illegible]	[illegible]					[illegible]		[illegible]		[illegible]
May [illegible]	[illegible]	[illegible]		[illegible]						[illegible]
May [illegible]	[illegible]		[illegible]			[illegible]				[illegible]
Total	[illegible]									[illegible]

The average length of the egg stage for May, 1922, is less than that for May, 1921, because the mean temperature was higher during the spring of 1922 than during the same period of 1921, as will be noted in Table 1. In 1922 the average time for first-generation eggs to hatch in April was 5.26 days, and in May 4.[illegible]1 days. The average incubation period for the two months was 4.86 days. Small larvae were found in peaches in the field on April 7 and 8, so hatching in the field in 1922 probably started a few days earlier than the first record given in Table 15, which was obtained in the insectary.

Incubation records on second-generation eggs were obtained during June, July, and August of 1922. (Table 16.)

TABLE 16.—*Length of incubation period of 88 second-generation eggs of the plum curculio, Fort Valley, Ga., 1922*

Date of oviposition	[illegible]	[illegible]				[illegible]
		2	3	4	5	
June [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	8
June [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	8
June [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	19
June [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	12
June [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7
June [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9
June [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	12
June [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	14
June [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10
Total	[illegible]					[illegible]
July [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
July [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
July [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
July [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
July [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
July [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
July [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
July [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total	[illegible]					[illegible]
Aug. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Aug. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Aug. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total	[illegible]					[illegible]

[1] Apples as host. Peaches as host for all others.

The average incubation period of second-generation eggs during the season of 1922 was 3.18 days. The average period in June was 3.18 days, in July 3.53 days, and in August 5 days. The incubation period of second-generation eggs which were hatching during the summer months is much shorter than the incubation period of first-generation eggs.

INCUBATION IN 1923

Incubation observations were made daily during the 1923 season. Records were made of 769 eggs of the first generation (Table 17) and 14 eggs of the second generation. The overwintered females oviposited over an unusually long period, extending from April to August. There was practically no second generation in 1923. Only 14 second-generation eggs were obtained from many first-generation adults during the season, and these were all deposited during August, when a number of first-generation beetles were confined together in a jar.

TABLE 17.—*Length of incubation period of 769 first-generation eggs of the plum curculio, Fort Valley, Ga., 1923*

Time of deposition	Eggs	Egg days	Average incubation period
	Number	*Number*	*Days*
Apr. 12 to 30	[illegible]	[illegible]	3.17
May	[illegible]	[illegible]	3.08
June	[illegible]	[illegible]	3.34
July	[illegible]	[illegible]	3.10
Aug. 1 to 3	[illegible]	[illegible]	3.20
Total or average	769	[illegible]	3.18

First-generation eggs, deposited on April 12, 1923, started to hatch on April 18. On the same date larvae 2 to 3 days old were found in peaches in the orchards, so hatching must have started several days earlier in the field than it did in the insectary. First-generation eggs hatched in an average of 3.17 days in April, 3.08 in May, 3.34 in June, 3.1 in July, and 3.2 in August. The average incubation period of first-generation eggs during the season was 3.18 days. Table 18 gives the incubation records on the 14 second-generation eggs. All of these eggs were deposited during August. The average incubation period was 3.04 days.

TABLE 18.—*Length of incubation period of 14 second-generation eggs of the plum curculio, Fort Valley, Ga., 1923*

Date of deposition	Number of eggs	Number of eggs hatching in specified number of days			Number of egg days
		2½	3	3½	
Aug. 2	1		1		3
Aug. 7	2			2	7
Aug. 17	1		1		3
Aug. 21	4	1	3		11½
Aug. 22	3		3		9
Aug. 26	2		2		6
Aug. 28	1		1		3
Total	14				42½

INCUBATION IN 1924

In 1924 all of the eggs used for incubation studies were examined twice in each 24-hour period to obtain the hatching dates. Records are available of 936 eggs of the first generation (Table 19) and [illegible] eggs of the second generation.

TABLE 19.—*Length of incubation period of 936 first-generation eggs of the plum curculio, Fort Valley, Ga., 1924*

Time of deposition	Eggs	Egg days	Average incubation period
	Number	*Number*	*Days*
Apr. [illegible] to 30	[illegible]	[illegible]	[illegible]
May	[illegible]	[illegible]	[illegible]
June	[illegible]	[illegible]	[illegible]
July 1 to [illegible]	[illegible]	[illegible]	[illegible]
Total or average	[illegible]	[illegible]	[illegible]

The average length of the egg stage for April, 1924, 6.08 days, is the highest average for any month recorded during the four years. Undoubtedly this was due to the low temperatures prevailing during that month. Table 1 shows that the mean temperature during April, 1924, was lower than the mean temperature for April of the other three years of these studies. The average incubation period of the eggs during May was 5.43 days, which is high. A period of cool weather occurring between May 8 and 12 delayed incubation about two days. The average incubation period of first-generation eggs during June and July was 3.03 and 2.81 days, respectively. The average incubation period of first-generation eggs during the season was 5.08 days. The eggs began to hatch on April 17.

During 1924 records on the incubation of second-generation eggs were obtained during July, August, September, and October. (Table 20.) This is the only year that incubation records are available for September and October. A number of second-generation eggs were deposited during September, and one female continued ovipositing until October 16.

TABLE 20.—*Length of incubation period of [illegible] second-generation eggs of the plum curculio, Fort Valley, Ga., 1924*

Time of deposition	Eggs	[illegible]	Average incubation period
	Number	Number	Days
July [illegible]	[illegible]	[illegible]	[illegible]
August	[illegible]	[illegible]	[illegible]
September	[illegible]	[illegible]	[illegible]
Oct. 1 to 16	[illegible]	[illegible]	[illegible]
Total or average	[illegible]	[illegible]	2.94

The average incubation period during July and August of 2.43 and 2.66 days, respectively, is lower than the average incubation period during the same months of the other years. Undoubtedly this was on account of the very hot weather during those months in 1924. Some of the eggs hatched in 2 days during July, which is the shortest incubation period of plum-curculio eggs on record. The average period of incubation for September was 4.25 days, and for October 5.58 days. On account of the cooler weather of late September and October, the length of the incubation period during those months approached that of the spring months. The average length of the second-generation egg stage for the season was 2.94 days. This is a little lower than the average incubation period of second-generation eggs during the other years, even though September and October records are included, and is undoubtedly due to the short period of incubation during July and August, when very high temperatures occurred.

INCUBATION DURING THE FOUR YEARS

Table 21 presents a summary of the incubation records taken in the four years. During this period 2,414 eggs were under observation for incubation records.

TABLE 21.—*Length of incubation period of eggs of the plum curculio, Fort Valley, Ga., seasons of 1921–1924*

Year	First-generation eggs				Second-generation eggs			
	Number	Maximum incubation period	Minimum incubation period	Average incubation period	Number	Maximum incubation period	Minimum incubation period	Average incubation period
		Days	*Days*	*Days*		*Days*	*Days*	*Days*
1921	270	12	2.0	4.33				
1922	33	9	2.0	[1] 4.65	60	5.0	2.5	3.14
1923	700	11	3.0	4.33	16	3.5	2.1	3.24
1924	1,600	8	2.5	5.08	263	7.0	2.0	2.94

[1] Record for April and May only; too high for season's average.

The incubation periods of first-generation eggs during the four years ranged from 2 to 12 days, with averages ranging from 4.33 to 5.08 days. The period of incubation of second-generation eggs ranged from 2 to 7 days, with averages ranging from 2.94 to 3.24 days. The average period for the incubation of first-generation eggs in 1922 should be lower for the season, as the figure given is for April and May only. The 1921 average does not include an average for April. As the mean temperatures during the spring of 1921 were lower than those in 1922, the incubation period for the season of 1921 would be longer than that for 1922, if records for each month from April to July were available for each year. There was very little difference in the average period of incubation of second-generation eggs during the three years reported. The average was a little lower in 1924 on account of the very hot July and August. The maximum period of seven days for the incubation of second-generation eggs occurred in October, 1924. There were no October records available for the other years.

THE LARVA

EMERGENCE OF LARVAE FROM PEACH DROPS

Most of the peaches in which curculio eggs are deposited before the stone starts to harden fall to the ground. Each season quantities of these drops were collected from under trees in commercial orchards and placed in frames (pl. 1, B) to obtain data on the maturity of larvae (pl. 7, B) and the comparative infestations of drops from different collections and from different orchards, and to supply material for insectary work. Conditions for the development of larvae are much more favorable in drops than they are in the green peaches that remain on the trees. There is a very heavy mortality of the larvae in the fruit on trees during the stone-hardening period, as explained on page 8. After the stone-hardening stage has passed and the fruit enters the ripening stage, conditions in the fruit on the trees again become more favorable for the growth of larvae that hatch a few weeks before peach harvest. A large part of the curculio infestation of the season, however, takes place from the beginning of the oviposition season in the spring until the stone of the peach begins to harden. As most of the peaches containing eggs or larvae during this period fall to the ground, the emergence of mature larvae from drops gives an excellent insight into the degree of infestation for the season, probable size of the second generation, progress of curculio development, etc.

During each of the four years that the life-history studies were under way 2½ bushels of drops were collected to obtain information on the comparative curculio infestation for these years and to determine the period that the larvae from early deposited eggs were leaving the fruit. These drops were collected each year when they began to fall in sufficient numbers to warrant a collection. They were placed in trays, and each morning the larvae that had reached maturity and left the fruit during the previous 24 hours were removed from the cloth-covered slides and recorded. These records, which are summarized in Table 22, present a comparison of the extent of the curculio infestation during the four years and show the period of heaviest larval emergence under orchard conditions.

TABLE 22.—*Emergence of first-generation larvae of the plum curculio from peach drops at Fort Valley, Ga., 1921-1924*

Year	Approximate date of full blossom of peach trees	Time of collection of drops	Emergence of larvae during—						Total larvae emerging
			April		May		June		
			Number	Per cent	Number	Per cent	Number	Per cent	Number
1921	Mar. [illegible]	Apr. [illegible]	12,229	98.5	190	1.5			[illegible]
1922	Mar. [illegible]	Apr. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1923	Mar. [illegible]	Apr. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1924	Mar. 29	Apr. 29	28	.9	3,142	99.1	[illegible]	[illegible]	3,170

Table 22 shows that 12,418 larvae of the plum curculio emerged from the 2½ bushels of drops in 1921. This represents a tremendous infestation, which was expected, because in 1920 the heaviest plum-curculio infestation ever experienced occurred in the Georgia peach belt. The records for 1922 indicate that the intensive curculio suppression campaign which was waged during 1921 had been very effective. A total of 2,753 larvae emerged from the 2½ bushels in 1922. The records for 1923 are not reliable for comparison. It was necessary to collect the 1923 drops from another orchard, and late in the season it was learned that the control measures advocated in the curculio-suppression campaign had not been enforced during previous seasons in this orchard. The 2½ bushels of drops yielded 9,379 larvae in 1923. Even though the curculio infestation of drops in this orchard may have been greater than in most of the other orchards, the general infestation in the peach belt probably was somewhat higher than in 1922, and had it not been that only one generation occurred that year, considerable curculio damage to the fruit crop might have been experienced. In 1924 the 2½ bushels of drops gave 3,170 larvae. There was more merchantable fruit in Georgia in 1924 than in any of the preceding years. Each year after 1920 the curculio damage to ripe fruit became less, in a large measure as a result of the various control measures that were enforced.

As may be noted from the approximate dates of full bloom of peach trees, given for each year in Table 22, the season of 1921 was early.

Peach trees were in full bloom by March 9, and matured larvae began to leave peach drops on April 3. From drops collected April 8, 98.3 per cent of the larvae emerged during April and 1.7 per cent during May. Two full generations occurred in 1921.

The blooming season of 1922 was about a week later than that of 1921. Larvae started to emerge on April 21; 91.1 per cent emerged during April, 8 per cent during May, and 0.9 per cent during June. Two full generations occurred in 1922.

The 1923 season was very late. Full bloom did not occur until March 27, and larvae did not start to reach maturity until May 1. There was only one generation in the field in 1923. From drops collected April 30, 99.4 per cent of the larvae emerged in May and 0.6 per cent in June.

The 1924 season was also late. However, a small second curculio generation occurred that year. Favorable conditions during the pupation season may have been responsible for the second brood. The first-generation larvae may have matured a little more rapidly in 1924 than in 1923, or eggs may have been deposited a little earlier, as matured larvae began to leave drops on April 23 in 1924. Full bloom did not occur until March 29 that year. From the 2½ bushels of drops collected on April 25, 0.9 per cent of the larvae emerged during April and 99.1 per cent during May.

During each of the four years, peach drops were collected at different times during the dropping season to determine for each collection the percentage of the total emergence from drops for the season, the period of emergence of larvae of the first generation in orchards, and the seasonal history of the insect in the larval stage as it occurred in the field.

Table 23 gives a summary of the emergence of larvae from drops collected at 10 different times during the season of 1921.

TABLE 23.—*Emergence of plum-curculio larvae from peach drops collected at different times during the season of 1921, Fort Valley, Ga.*

Date of collection	Period of emergence	Number emerged	Percentage of total
Apr. 1	Apr. 8 to 24	[illegible]	[illegible]
Apr. 5	Apr. 10 to May 1	[illegible]	[illegible]
Apr. 12	Apr. 13 to May 22	[illegible]	42.9
Apr. 19	Apr. 20 to May 21	[illegible]	[illegible]
Apr. 25	Apr. 26 to May 31	[illegible]	[illegible]
May 3	May 4 to June 1	[illegible]	[illegible]
May 10	May 12 to June 2	[illegible]	[illegible]
May 19	May 20 to June 8	[illegible]	[illegible]
May 27	May 28 to June 20	[illegible]	[illegible]
June 4	June 5 to 13	[illegible]	[illegible]
Total		[illegible]	100.0

The first matured larvae to emerge during the 1921 season were those that issued on April 8 from drops collected on April 1. The table shows that 42.9 per cent of all the larvae emerging from drops during the season came from the third collection made on April 12. The first five collections in 1921 gave 85.1 per cent of the larvae. The first and second collections were made too soon in 1921. If they had been delayed until about April 9, three collections, timed about April 9, 17, and 25, would have sufficed for commercial purposes and would have netted around 85 per cent of the larvae. The data collected on this subject during the four years revealed the fact that the first collection of drops should be made about one month after full bloom. In 1921 full bloom occurred on March 9.

Table 24 gives a summary of the emergence of plum-curculio larvae from drops from 96 Belle peach trees, collected at different times during the season of 1922.

TABLE 24.—*Emergence of plum-curculio larvae from drops from 96 Belle peach trees, Fort Valley, Ga., 1922*

Date of collection	Quantity of peach drops	Period of emergence	[illegible]	[illegible]
	Bushels			
Apr. 19	⅝	Apr. 21 to June 3	[illegible]	[illegible]
Apr. 26	¾	Apr. 25 to May 20	[illegible]	[illegible]
May 1	1⅞	May 2 to 18	[illegible]	[illegible]
May 8	1⅛	May 10 to 23	[illegible]	[illegible]
May 15	⅛	May 17 to June 6	[illegible]	[illegible]
June 5	⅝	June 6 to 10	[illegible]	[illegible]
Total			[illegible]	[illegible]

The first collection of drops was made on April 19, about one month after full bloom, which occurred on March 16 in 1922. This collection gave 62.6 per cent of the larvae emerging from all drops. The first three collections gave 88.3 per cent of the total larvae. The first matured larvae to leave peach drops in the insectary in 1922 came out on April 21. Two larvae in peaches collected in the field had reached maturity and left the fruit on April 19.

Table 25 gives a summary of the emergence of plum-curculio larvae from drops collected at different times during 1923 from under trees in five rows of Belle peach trees.

TABLE 25.—*Emergence of plum-curculio larvae from drops collected under five rows of Belle peach trees, Fort Valley, Ga., 1923*

Date of collection	Quantity of peach drops	Period of emergence	[illegible]	[illegible]
	Bushel			
May 2	⅝	May 3 to June 3	[illegible]	[illegible]
May 7	⅞	May 8 to June 5	[illegible]	[illegible]
May 14	½	May [illegible] to June 1	[illegible]	[illegible]
May 21	⅝	May 22 to June 7	[illegible]	[illegible]
May 28	¼	May 29 to June 12	[illegible]	[illegible]
June 9	¾	June 10 to 12	[illegible]	[illegible]
Total			[illegible]	[illegible]

The first collection of drops made on May 2, just a little over one month after full bloom, which occurred on March 27, gave 55.2 per cent of the larvae that emerged from all drops. The first three collections gave 89.7 per cent of the total larvae that emerged from all drops during the season. The first larva to mature in peach drops under field conditions in 1923 came out on April 30 from peach drops brought to the insectary April 27.

Table 26 gives a summary of the emergence of plum-curculio larvae from peach drops collected weekly during the dropping season in 1924 from Hiley peach trees.

TABLE 26.—*Emergence of plum-curculio larvae from drops (1 peck per collection) from Hiley peach trees, Fort Valley, Ga., 1924*

Date of collection	Period of emergence	Number of larvae	Percentage of total
May 1	May 2 to 14	3	3.0
May 8	May 9 to 17	31	31.3
May 15	May 15 to 18	53	53.5
May 22	May 23 to 27	6	6.1
May 29	June 2 to 4	6	6.1
Total		99	100.0

Full bloom occurred on March 29, and the first collection of drops was made on May 1. The first three collections gave 87.9 per cent of the larvae that emerged from drops during the season. The first larva to reach maturity in drops under field conditions in 1924 emerged on April 29.

PICKING UP PEACH DROPS

The data presented in Tables 22 to 26, inclusive, show that the little peaches that begin to drop to the ground about a month after full bloom are usually very heavily infested with first-generation curculio larvae. The collection and destruction of these drops by burying them in a trench, at least 24 inches below the surface of the soil, and covering with a layer of quicklime before filling in with soil, or by boiling the drops, will materially reduce the number of first-generation adults that deposit eggs in the fruit just before and during the harvesting season, when two generations occur, or during the following season, when there is but one generation. This supplementary control measure has been strongly recommended in the Georgia peach belt and has been adopted by a majority of the growers. The data show that three collections of drops will get around 90 per cent of the larvae that fall to the ground in the small peaches during the season. The first collection should be made about one month after full bloom or when there are enough drops down to warrant a collection. The other two collections should be made at intervals of five or six days.

An orchard of 1,394 Belle peach trees was divided into two equal plats, and care exercised in the division to avoid subjecting one side to a greater area of possible curculio hibernating quarters than the other. The drops were collected six times from plat 1, although the last two collections were unnecessary, and on plat 2 they were allowed to remain on the ground throughout the season. Both plats were otherwise treated exactly alike. They received the spray applications consisting of the same materials on the same days, and the cultivation in each was always done on the same days.

At harvest the fruit from 8 record trees in the center of each block was cut open to obtain data on the curculio infestation. The 4,842 ripe peaches from 8 trees in plat 1 contained 58 infested peaches, or 1.2 per cent, whereas the 6,182 peaches from 8 trees in plat 2 had 139 infested peaches or 2.2 per cent. An average of three crates of peaches per tree were harvested from this orchard in 1922. The picking up of drops reduced the curculio damage nearly one-half, and 33 crates of merchantable fruit per thousand trees were saved. This fruit, at $2.25 per crate, was worth $74.25. After deducting the cost of gathering the drops during the season ($28.80), there was a net saving of $45.45 per thousand trees. This would be a net saving of around $4.50 per acre. The chief benefit from the operation, however, is that of preventing the development of myriads of adults, and thereby reducing the infestation in subsequent peach drops, which can not be computed definitely in dollars and cents.

The cost of picking up drops is surprisingly low in Georgia, where cheap negro labor is used. (Pl. 6, B.) Much of the early opposition to this control measure was based on the fear that the expense would be too heavy. Table 27 shows that six collections of drops were made in one Georgia orchard for 2.88 cents per tree. Data on drops show that three collections will get most of the larvae that fall during the season. The last three collections shown were not really necessary. The cost of the first three collections was 2.14 cents per tree.

TABLE 27.—*Cost of picking up peach drops, Fort Valley, Ga., 1922*

Date of collection	Size of peaches	Quantity of drops from 96 trees	Larvae in drops	Proportion of total larvae emerging from drops	Cost of gathering drops (per 100 trees)
		Baskets[1]	*Number*	*Per cent*	*Dollars*
Apr. 19	Small	8	397	62.6	0.92
Apr. 24	do	6½	106	16.7	.56
May 1	Mostly large	19	57	9.0	.66
May 8	Large	15	12	1.9	.46
May 15	do	½	57	9.0	.09
June 5	do	1	5	.8	.19
Total		50½	634	100.0	2.88

[1] Each basket held five-eighths of a bushel.

The very small peaches that fall first contain most of the larvae, and the percentage of infested drops decreases as the larger fruits fall. When negro children are employed to pick up drops, they will gather all the large ones, especially if they are paid by the basket, which is not a good practice, but frequently leave on the ground the small ones that are very likely to be infested. Care should be exercised to see that the laborers gather all the drops. In one case 52 matured plum-curculio larvae emerged from small peach drops which were collected from under trees just after a commercial gathering had been made by negro laborers.

Some growers have tried to destroy the larvae in drops by submerging them in water, or by throwing them into rivers, ponds, or other bodies of water. It is surprising how long curculio larvae will remain alive in drops submerged in water. Undoubtedly, many would escape from drops floating to the river or pond banks.

In 1921 the writer observed that unprotected larvae apparently could live for some time in water before being drowned. Sometimes rain or water from decaying peaches would collect at the bottom of emergence cages, and larvae that had been on top of this water for some time would revive when removed and placed on soil. One larva and one pupa were placed in water in a small jar in 1921 and left for 24 hours; when removed, both revived in a short time.

Some special tests were conducted in 1922 to determine how long larvae were able to live in peaches and apples submerged in water. Three lots of peaches and four lots of apples containing curculio larvae were placed in water on August 9 and kept submerged for periods of 18½, 24, 48, and 72 hours. The results may be summarized as follows:

In peaches submerged 18½ hours: Four larvae were removed, all appeared dead at first, but became active in 30 minutes; when placed on soil, all entered.

In apples submerged 18½ hours: Two larvae were removed; they moved and entered the soil, but were not as active as those from peaches.

In peaches submerged 24 hours: Three larvae were removed; all were inactive at first; 2 became active in 30 minutes and later entered the soil, 1 did not recover.

In apples submerged 24 hours: Three larvae were removed, 1 being active and 2 inactive; all were active in 30 minutes; 1 larva entered the soil, 2 remaining larvae did not enter the soil.

In peaches submerged 48 hours: Two larvae were removed, both revived in about two hours; they were placed on soil, where they remained alive about two hours but never entered.

In apples submerged 48 hours: Three larvae were removed; all recovered but did not enter soil.

In apples submerged 72 hours: Three dead larvae were removed.

Tests were also conducted in August, 1922, to determine how long unprotected larvae and pupae would remain alive in water. The results were as follows:

Two larvae, in water 2½ hours: Both appeared dead, but one became active in 8 minutes and the other in 10 minutes; they were placed on soil, but did not enter.

Two larvae, in water 18½ hours: One was dead and one alive.

Two larvae, in water 20 hours: One was dead and one alive.

Three pupae, in water 21½ hours: One was dead and two were alive. The live ones were again placed in the water and 16 hours later they were found dead.

Four pupae allowed to float on surface of water: After 24 hours all were alive; after 48 hours 1 was dead and 3 were alive; after 72 hours 3 were alive; after 113½ hours 2 were dead and 1 was alive; after 209½ hours the last one was dead.

In 1923 some observations were made on the length of time the adults could remain alive in water. One adult curculio was noted to be alive on March 19 after having been in water for 52 hours. On March 19 four other curculio beetles were placed in a jar of water. At the end of 26 hours, during 6 hours of which the water was covered by ice, 3 of the 4 beetles were alive, and after 144 hours these 3 were still alive.

EXPOSING PEACH DROPS TO THE SUN

Some peach growers have expressed the opinion that if peach drops could be exposed to the direct sun rays many of the curculio larvae therein would not be able to mature, and a few growers have made efforts to pull the drops out from under the trees for exposure to the sun, instead of picking them up for destruction. This opinion was apparently well founded, as Crandall,[8] of Illinois, showed some years ago that many curculio larvae in apples were prevented from maturing by exposing the fruit to the sun. In 1924 the writer conducted an experiment to determine the effect of direct rays of the sun on curculio larvae in peach drops. On May 1, 50 peach drops were placed in each of 8 boxes, partly filled with soil, and exposed to the direct rays of the sun. The drops in four boxes were placed on top of the soil, whereas the drops in the other four boxes were placed about 2 inches below the soil surface.

---

[8] Crandall, C. S. [illegible]

Periodical examinations of the glass-bottomed boxes between May 1 and July 27, and sifting of the soil on July 27, did not reveal a single larva from the boxes in which the drops were placed on top of the soil. Examinations of the boxes in which the drops had been buried 2 inches below the soil surface showed that some larvae had left the drops, and soil cells could be seen against the glass bottoms. When the soil was sifted on July 27 four dead larvae were found in these boxes. There was no adult emergence from any of the eight boxes. The drops for this experiment were taken from a lot which was known to have about 20 per cent curculio infestation.

The results of this test show rather definitely that the direct sun rays have a decided action on the curculio larvae in peach drops. Hot and dry weather during the dropping season, especially if the drops are brought out from under the trees, perhaps brings about the mortality of many larvae in the little peaches on the ground. Of course, growers should not depend on the possibility that larvae will be killed in drops exposed to the direct sun rays. Collecting and destroying them is the sure method of reducing the number of adult curculios in peach orchards.

UNDERSIZED LARVAE

During each of the four years undersized larvae were noted to leave drops and when placed on soil they would work their way into it as if for pupation. No adults were reared from these larvae. Quaintance and Jenne [4] are of the opinion that undersized larvae leave the fruit on account of an unfavorable condition of the fruit, or on account of an unhealthy condition of the larva itself. In 1924 a careful record was kept of the normal and undersized larvae that emerged from peach drops during the season. A total of 4,745 larvae left the fruit between April 29 and June 4; 973, or 20.5 per cent, of these larvae were undersized. The percentage of undersized larvae is perhaps higher during the beginning of the dropping season than later on.

TIME OCCUPIED BY LARVA IN ENTERING SOIL

When the larvae become full grown they leave the host, and immediately upon reaching the soil they prepare to enter it for pupation. It is during these few minutes on the soil, before entering it, that many larvae are killed by predacious enemies. Ants [5] are very numerous in Georgia peach orchards, and without doubt they kill many curculio larvae as they leave the fruit to enter the soil. Ants have often been noticed carrying curculio larvae. Many times they have killed hundreds of larvae that were placed in pupation or parasite boxes for life-history records. The time required for the larvae to enter the soil depends, of course, on the kind of soil, its moisture content, state of cultivation, etc. Thirty observations were made on this point in 1922. Sandy loam, gently packed or fairly wet, was used for these observations, which showed that the time occupied in entering the soil ranged from 1 to 7 minutes, with an average of 3.12 minutes from the time that each larva began to enter the soil until it was out of sight.

---

[4] QUAINTANCE, A. L., and JENNE, E. L. Op. cit.

[5] *Formica rufa* var., *Prenolepis imparis* Say., *Lasius* sp., *Pheidole* sp.

EMERGENCE OF SECOND-GENERATION LARVAE

During 1921 a record was taken on the emergence of second-generation larvae from peaches in which first-generation adults had oviposited. A total of 355 second-generation larvae emerged from the peaches during the period from July 9 to September 10 of that year. Of these, 52.4 per cent emerged in July, 45.9 per cent in August, and 1.7 per cent in September. The Elberta peaches were moving during the first 15 days of July.

The first full-grown second-generation larvae emerged in 1921 on July 9, and in 1922 on June 30, whereas the first full-grown second-generation larva to leave the fruit in 1924 was not recorded until August 4. There was no second generation in the field in 1923, and records were obtained on only five second-generation larvae in the insectary. The first one left the fruit on August 12, and the others on August 21 and 22 and September 7 and 11. When a second generation of the plum curculio occurs under normal conditions in Georgia, the emergence of second-brood larvae from the fruit is much earlier than indicated by the records obtained in the insectary in 1923.

TIME SPENT IN THE FRUIT

No records are available for the length of time spent by larvae in the fruit in 1921. However, during the seasons of 1922, 1923, and 1924 many records were made on the length of time required by plum-curculio larvae to reach maturity in the fruit, and the length of the egg and larval stages combined, for both generations.

The average time for the first-generation larvae hatching in April, 1922, to reach maturity in peaches was 21.5 days, and for those hatching in May, 13.3 days. The average time spent in the fruit as egg and larva by individuals from eggs laid in April was 24.5 days, and from eggs laid in May, 17.8 days. The average time for the larvae to mature during the season, based on 40 records, was 14.9 days, and the average time spent in the fruit as both egg and larva was 20.3 days.

The average time for second-generation larvae to mature in June, July, and August of 1922 was 12.7 days, based on six records, and the average time spent in the fruit as egg and larva during the same period was 15.5 days.

Records are available for the combined second-generation egg and larval stages in peaches and apples, in 1922, for 709 individuals. Apparently more time is required for curculio larvae to reach maturity in apples than in peaches. The average time spent in peaches as egg and larva by individuals from eggs laid in June was 12.2 days and from eggs laid in July, 16.7 days, whereas the average time spent in apples by individuals starting in July was 27 days and by those starting in August and September 27.1 and 28.3 days, respectively. The average time spent in both peaches and apples by the egg and larval stages of the second generation during 1922 was 20.3 days. The average period for the season in peaches alone is much lower, as shown in the preceding paragraph.

The average time spent in the fruit by the first-generation larvae hatching in May, 1923, was 15.7 days, and for those hatching in June, July, and August, 13.5, 12.4, and 12.8 days, respectively. This shows that the time spent in the fruit as larva decreases as the season progresses. First-generation larvae became full grown in the fruit in an average period of 14 days in 1923, based on 147 records.

The average time spent in peaches by the egg and larval stages combined of 130 individuals of the first generation in 1923, from eggs deposited in May, June, and July, was 19.1, 17.5, and 15.5 days, respectively. The average time for the season was 17.8 days.

There was no second generation of the curculio in the field in 1923; however, records of six individuals of the second generation were obtained in the insectary. The average time spent in the fruit by 3 larvae was 14.3 days and the average time as egg and larva by 3 other individuals was 14 days. The three larvae were hatched on August 11 and 24, whereas the three individuals observed for egg and larval stages combined were from eggs deposited August 4 and 5. This may account for the difference in the length of the larval stage of the several individuals. These records are too few to warrant serious consideration of this difference.

In 1924 the average time spent in the fruit as egg and larva by individuals of the first generation starting in May was 17.2 days and by those starting in June, 15.1 days. The average time during the season was 16 days, based on 109 records.

For individuals of the second generation starting in August, 1924, 15.2 days were required for the egg and larval stages in the fruit, and for those starting in September, 26.4 days. The average time spent as egg and larva in the fruit during the season was 17 days, based on 57 records.

Table 28 gives a summary of the records taken during 1922, 1923, and 1924, on the time required for plum-curculio larvae to reach maturity in the fruit and the time spent in the fruit as egg and larva. The table shows that curculio larvae reach maturity in the fruit more rapidly during the summer months than during the spring and fall months.

TABLE 28.—*Summary of time required for plum-curculio larvae to reach maturity in fruit and time spent in fruit by egg and larval stages combined, Fort Valley, Ga., 1922–1924*

Time of hatching or of egg deposition [1]	Larval stage		Egg and larval stages combined	
	First generation	Second generation	First generation	Second generation
1922	Days	Days	Days	Days
April	[illegible]		[illegible]	
May	[illegible]		[illegible]	
June–August		[illegible]		
June				[illegible]
July				[illegible]
[illegible]				[illegible]
August				[illegible]
September				[illegible]
Average	[illegible]	[illegible]	[illegible]	[illegible]
1923				
May	[illegible]		19.1	
June	[illegible]		17.5	
July	[illegible]		15.5	
August	[illegible]	14.3		14.0
Average	[illegible]	14.3	17.8	14.0
1924				
May			17.2	
June			15.1	
August				15.2
September				26.4
Average			[illegible]	[illegible]

[1] Time of hatching for those observed for larval period; time of egg deposition for those observed for egg and larval stages combined.

[2] [illegible]

[3] In both apples and peaches; the average for individuals in peaches in June and July was about [illegible] days.

[4] [illegible]

THE LARVA, PUPA, AND ADULT IN THE SOIL

During the four years 1921 to 1924, inclusive, many records were taken of the time spent in the soil by the curculio as larva, pupa (pl. 7, C), and beetle, or from the time that the larva entered the soil for pupation until the resulting beetle emerged. Data on both generations were taken. The records on individual specimens were obtained by rearing the insect in vials. Pupation boxes (pl. 7, A) were used for records on a number of individuals in the same box. Plum-curculio larvae will not make a soil cell for pupation in the presence of light. In order to make conditions favorable for pupation, the vials were pushed down into sand, and soil was placed around the sides of the pupation boxes, to prevent any light from reaching the glass bottoms. If any light was admitted the soil cells would not be constructed on the glass bottoms, where the development of the insect could be observed. Moist sand or moist sandy loam was the best medium for pupation. Moist sawdust, shavings, and clay have been used for pupation, and while the larvae made soil cells in these materials against the glass bottoms of the pupation boxes, they apparently preferred moist sand or sandy loam for pupation. The larvae seem to contract within the larval skin just before pupating, causing the anal end to be transparent. The pupae apparently abhor light, as they always wiggle violently when the vials or pupation boxes are lifted out of the soil to the light. The pupae gradually turn yellowish brown and finally shed the pupal skin. The eyes of the pupa turn black, and then the mandibles darken a few days before the skin begins to darken. The adults just after transformation are yellowish brown, but with age they darken to dark brown varied with gray.

TIME SPENT IN SOIL IN 1921

The weather was exceedingly changeable during the pupation season of the first generation in 1921, and pupation and adult emergence were somewhat delayed. Some of the larvae examined during the spring of 1921, after they had been in the soil 21 days, showed no signs of pupation. When these larvae were replaced on top of the soil they readily reentered it. The first pupa found in the field in 1921 was noted on May 9. On May 11 a careful examination was made of the condition of the larvae in the soil under trees in orchards. This examination showed that about one-half the larvae in the soil on that date had pupated. The first pupa in the insectary in 1921 was recorded on May 14. This pupa was found in an indoor box in which curculio larvae had been placed on April 15 and 17.

Records on the length of the pupal stage of the first generation of the plum curculio in 1921, and the time spent in the soil as larvae, were taken on 230 individuals. The average time spent in the pupal stage by first-generation individuals entering the soil in April and May was 10.6 days. The average time spent in the soil before pupation by the first generation larvae entering in April was 26.9 days, in May, 18.5 days, and in June 12.2 days, with an average of 25.8 days for the season. The time spent in the soil as larva and pupa by those entering in April was 38.7 days, as compared with 29.0 days for those entering in May, the average for the season being 34.9 days.

Records taken during 1921, on the total length of time spent in the soil by 672 individuals of the first generation of the plum curculio in the larval, pupal, and adult stages combined, show that the curculios which entered the soil as larvae in April spent 61 days in the soil, those entering in May, 20.5 days, and those entering in June, 31.4 days, with an average of 48.6 days for the season.

The records of another lot of 293 curculios of the first generation which entered the soil as larvae during April, 1921, show that the average time spent in the ground by these individuals was 57.7 days.

Records of 41 individuals show that the average time spent in the pupal stage by the second generation entering the soil during July, 1921, was 8.5 days, and for those entering during August, 8.9 days, with an average of 8.7 days for the season. Ten days were spent in the larval stage in the soil before pupation by second-generation individuals entering during July and August. The average time spent in the soil as larva and pupa by second-generation individuals entering the soil during July and August was 18.1 and 18.9 days, respectively, with an average of 18.5 days for the season.

The length of time spent in the soil during the 1921 season by 74 individuals of the second generation in all stages combined was 27.2 days for those entering in July, and 27 days for those entering in August, with an average of 27.1 days for the season.

TIME SPENT IN THE SOIL IN 1922

The first pupa in 1922 from a field larva was recorded on May 17. On May 19 two pupae were recorded from larvae reared in the insectary. Eleven records were taken of the first generation of 1922, for the time spent in the soil as larva, pupa, and adult. The larvae used in this study were hatched in the insectary from eggs deposited by beetles after hibernation. The records were made from individuals in vials. The number of records is small, because many of the larvae which were to be used in this study were killed by ants, spiders, and fungus, and some were undersized.

The average length of the pupal stage of the first generation in 1922 was 9.2 days for those entering the soil in May and 6.1 days for those entering in June, 7.6 days being the average for the period. The average time spent in the soil as larva before pupation was 14.2 days for those entering in May and 13 days for those entering in June, with an average of 13.6 days for the season. One record was made of an individual remaining in the soil as a larva for 38 days before pupating. The average time spent in the soil as a beetle after pupation was 15.8 days for those entering the soil in May and 6.7 days for those entering in June, with an average of 11.9 days for the season.

The average total time spent in the soil by the first generation in 1922 during its development was 38.8 days for those entering in May, and 26.7 days for those entering in June, the average for the season being 33.6 days.

Records were taken of the time spent in the soil during the development of another series of 84 first-generation individuals, also from eggs deposited in 1922 by hibernated adults. The records were made from pupation boxes. Many of the larvae of this series also were killed by ants, spiders, and fungus, and some were undersized. In this series, 29.2 days were spent in the soil by individuals entering in May, and 30.1 days by those entering in June; the average was 29.3 days for the season.

Data on the length of the pupal stage and the time spent in the soil as larva and as adult were recorded for 174 first-generation individuals that were reared in vials containing from 1 to 1½ inches of sandy loam soil, very lightly packed and kept normally moist. The larvae for this series were obtained from peach drops collected in a commercial orchard. These records show that the average length of the pupal stage was 10.8 days for individuals entering the soil in May and 8.3 days for those entering in June, with a seasonal average of 10.4 days. An average period of 14.6 days was spent in the soil as larva before pupation by those entering in May and 11.2 days by those entering in June, or an average of 14.2 days for the season. The beetles from larvae entering in May remained in the soil 7.1 days after pupation, and those entering in June, 11.4 days, with a seasonal average of 7.4 days. The average total time spent in the soil during the development was 32.6 days for individuals entering in May and 28.2 days for those entering in June; the average for the season was 32.2 days.

Records were also made of the time spent in the soil for 196 first-generation individuals that were reared in pupation boxes. The adult emergence from some of the boxes was very low, probably because many larvae were undersized, and ants killed a number of larvae in several boxes. In some of the boxes about one-half inch of sand was placed in the bottoms, then the larvae allowed to enter, after which from 1 to 1½ inches of sandy loam was placed on top of the sand. In other boxes sandy loam was used for both layers of soil. Best results were obtained from using sandy loam. The sand may account for the low emergence in certain boxes. Larvae for this series were also obtained from peach drops collected in a commercial orchard. These records show that individuals of the first generation which entered as larvae in April spent an average of 40.8 days in the soil and those entering in May spent 30.6 days, or an average of 39.3 days for the season.

Table 29 gives the length of time spent in the soil by 1,408 first-generation curculios. These larvae were confined in parasite boxes, primarily for records on curculio parasites.

TABLE 29.—*Length of time spent in the soil by 1,[illegible] plum curculios of the first generation of 1922, Fort Valley, Ga.*

Date larvae entered the soil	Number of larvae	Number of adults emerging in [illegible]																												Total number of adults
		33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	
Apr. [illegible]	[illegible]							3	9	1	6				1															[illegible]
Apr. [illegible]	[illegible]	1						10	20	14	15																			[illegible]
Apr. [illegible]	[illegible]							39	27	23	24																			[illegible]
Apr. [illegible]	[illegible]							20	34	46	27																			[illegible]
Apr. [illegible]	[illegible]							11	15	15	5																			[illegible]
Apr. [illegible]	[illegible]	1						75	67	78	75																			[illegible]
Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	158	172	177	152	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1,[illegible]
May [illegible]	[illegible]							3		4	10																			[illegible]
May [illegible]	[illegible]							30		23	31	13	10																	[illegible]
Total	879	1	3	1	9	13	34	33	48	27	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Grand total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1,[illegible]

In this series an average period of 41.27 days was spent in the soil by individuals entering in April and 41.33 days by those entering in May, the average being 41.29 days for the season.

The first pupa of the second generation in 1922 was observed in the insectary on July 7. This individual was reared from an egg deposited in the insectary by a first-generation female. Observations and records show that the first-generation females do not start to deposit eggs until 10 or 12 days after emergence, during seasons when there are two generations.

Records were taken of the length of the pupal stage of the second generation in 1922 and of the time spent in the soil as larva and adult. The 10 larvae for this study were reared from eggs deposited by beetles captured in the field. The average pupal stage was 9.8 days. The average time spent in the soil as larva before pupation was 15.2 days, and as adult after pupation, 7.3 days. The average total time spent in the soil by the second generation in 1922 was 32 days.

The records of the length of time spent in the soil by 80 individuals of the second generation, in all stages combined, during 1922, show that the average time for individuals entering the soil during July was 31.3 days. These individuals were reared in pupation boxes, and the adult emergence was low, on account of the presence of undersized larvae and mortality of larvae caused by ants, spiders, and fungus.

Data on the length of the pupal stage of the second generation of 1922 and the time spent in the soil as larva and as adult were recorded for 207 individuals reared in individual vials. The larvae for this study were from eggs deposited by first-generation adults that were reared in the insectary. The average time spent in the pupal stage by individuals entering as larvae in July, August, and September was 8, 8.2, and 9.4 days, respectively, and the average for the season was 8.2 days. The time spent in the soil as larva before pupation was 11.6 days for those entering in July, 9.4 days for those entering in August, and 9.2 days for those entering in September, with an average of 10.7 days for the season. The time spent in the soil as a beetle before emergence was 6.7 days for those entering in July, 6.8 days for those entering in August, and 12.2 days for those entering in September, and the average for the season was 7.2 days. The total time spent in the soil by the second generation in 1922 was 26.3 days for individuals entering in July, 23.7 days for those entering in August, and 29.8 days for those entering in September, the average for the season being 26.1 days.

Records were taken on the total length of time spent in the soil by 82 other individuals of the second generation in 1922. These larvae were reared in pupation boxes, and were from eggs deposited by first-generation adults that were reared in the insectary. The average time spent in the ground by the curculios of this series was 28.8 days for those entering in July, 29.8 days for those entering in August, and 29.3 days for the season.

Several larvae of a third generation were reared in the insectary during 1922 from eggs deposited by second-generation insectary-reared adults. These all died after entering the soil, except one individual which entered the soil as a larva on September 11 and emerged as a beetle 25 days later.

TIME SPENT IN THE SOIL IN 1923

The first pupa of the 1923 season was formed on May 19. This individual left the fruit on May 2 and had been reared in a peach drop collected in a commercial peach orchard. Records were taken on 120 individuals of the first generation relative to the time spent in the soil as larva, pupa, and adult during 1923. The larvae for this study were taken from peach drops and confined in individual vials. The average length of the pupal period was 9.2 days for individuals entering in May, 9.9 days for those entering in June, and 10.9 days for those entering in August, with an average of 9.7 days for the season. The average time spent in the larval stage in the soil before pupation was 16.9 days for those entering in May, 11.5 days for those entering in June, and 15.4 days for those entering in August, with an average of 14.4 days for the season. The average time spent in the soil as first-generation beetles after pupation was 15.8 days for those entering in May, 15.3 days for those entering in June, 3.4 days for those entering in August, and 13.5 days for the season. The average total time spent in the soil during the development of first-generation individuals entering in May, June, July, and August was 43.4, 35.8, 31.8, and 33.4 days, respectively, the average for the season being 37.5 days.

The average total length of time spent in the soil during the development of the first generation in 1923 by 1,471 individuals which were reared in pupation boxes containing massed larvae and entered the soil in May, was 37.8 days.

If there was a second generation of the curculio in the field in 1923, it was so small that it was of no importance. The fruit was all harvested before the first-generation beetles left the soil in numbers. Field observations indicated that only one generation occurred in the field. No oviposition was recorded in the insectary from individual pairs of the first generation, but a few eggs were taken from jars in which were massed a number of first-generation adults. These eggs made available several records on the pupal stage of the second generation and the time spent in the soil as larva and adult. One individual left the fruit on August 22, spent 24 days in the soil as larva, 9 days as pupa, and 8 days as beetle, or a total of 41 days. One individual entered on August 13 and spent a total period of 25 days in the soil. Another entered on September 11 and was in the soil 31 days.

TIME SPENT IN THE SOIL IN 1924

The first pupa of the season of 1924 was formed on May 28 by an individual that left the fruit on May 1 and had been reared from a peach drop collected in a commercial peach orchard. The length of the pupal stage of the first generation and the time spent in the soil as larva and as adult were recorded in 1924. The 149 larvae used for this study were taken from peach drops and confined in individual vials. The average length of the pupal period of individuals entering in May, June, and July was 9.5, 7.9, and 8.3 days, respectively, and for the season it was 8.8 days. The average time spent in the larval stage in the soil before pupation was 19.9, 9.1, and 13.5 days, for those entering in May, June, and July, and 15.7 days for the season. The average time spent in the soil as beetles after pupation was 7.3, 8.3, and 7.3 days for those entering in May, June, and July, and for the season it was 7.7. The average total time spent in the soil during the development of first-generation adults was 33.2 days for May entrants, 29.8 days for June entrants, 31.5 days for July entrants, and 32.4 days for the season.

The total length of time spent in the soil during the development of the first generation was recorded for 1,370 individuals which were reared in pupation boxes containing massed larvae. These records can not be absolutely correct for the number of days from the time the larvae entered the soil until the beetles emerged, as the larvae were placed in each pupation box on several days. These records show that about 42 days were spent in the ground during the development of these first-generation individuals which entered the soil in May, 1924.

The first pupa of the second generation in 1924 was observed in the insectary on August 15. This individual was reared from an egg deposited in the insectary by a first-generation female.

Forty records were taken of the length of the pupal stage of the second generation of the plum curculio in 1924, and of the time spent in the soil as larva and adult. The larvae for these studies were reared from eggs deposited by insectary-reared first-generation adults. The observations were made in individual vials. The average time spent in the pupal stage was as follows: Those entering in August, 9 days; in September, 7 days; for the season, 8.1 days. The time spent in the soil as larva before pupation was 10.1 days for those entering in August, 16.5 days for those entering in September, and 16 days for one entering in October, with an average of 13.2 days for the season. The time spent in the soil as a beetle before emergence was 20.5 days for those entering in August and 15 days for those entering in September, the average being 20 days for the season. The total time spent in the soil by the second generation in 1924 was 32.2 days for August entrants and 33.8 days for September entrants, with an average of 32.9 days for the season.

EFFECT OF MOISTURE ON THE TRANSFORMATION OF THE CURCULIO IN THE SOIL

In order to maintain normal conditions in the insectary for pupation the individual pupation vials and pupation boxes had to be moistened every few days. This was apparently necessary for pupation and facilitated the escape of the adults from the soil. It was found that when the soil was allowed to dry out very few adults emerged. They died either during pupation or as adults trying to escape from the hard dry soil. Hence droughts and dry periods will prolong the period spent in the soil during development in the orchards or bring about mortality of the insects during pupation or before the escape of the adults. Even though the adults appear from hibernation at the normal time, a drought or dry period during the pupation season of the first generation may delay the emergence of the adults to such an extent that the fruit will be off in Georgia before a second generation can be produced. This condition is probably sometimes responsible for an occasional single brood of the plum curculio per season in Georgia.

DISKING FOR THE DESTRUCTION OF PUPAE

Pupation takes place within the top 2 inches of soil, although an individual may occasionally go to a depth of 3 inches to pupate. The writer's observations indicate that perhaps three-fourths of the larvae pupate within the top inch of soil. Upon entering the soil the larvae prepare a soil cell in which the pupal period is passed. (Pl. 8.) The pupa of the curculio is extremely delicate and tender. If the soil cell is broken while the insect is in the pupal stage, the pressure and heat of the soil will soon kill it. If the soil cell is broken while the insect is still in the larval stage, invariably another cell will be constructed; however, if the insect is in the pupal stage, the construction of a second cell is impossible.

Disking during the pupation season of the first generation is therefore recommended. Pupae not killed directly by the pressure and heat of the soil are perhaps frequently killed by exposure to light and sun or to predacious insects. This disking, which is a part of good orchard management, should lessen the size of the second brood of "worms," when two generations occur, and materially reduce the number of hibernating adults to attack the next season's peach crop. In Georgia the disking for destruction of pupae should begin about May 10 and continue throughout June. This cultivation should be given weekly, if possible, and to a depth of several inches. Special attention should be given to the disking under the spread of the trees, where most of the pupation takes place.

An experiment was conducted in 1924 to determine the value of disking to prevent the emergence of adult curculios from the soil. Table 30 gives the results of this experiment.

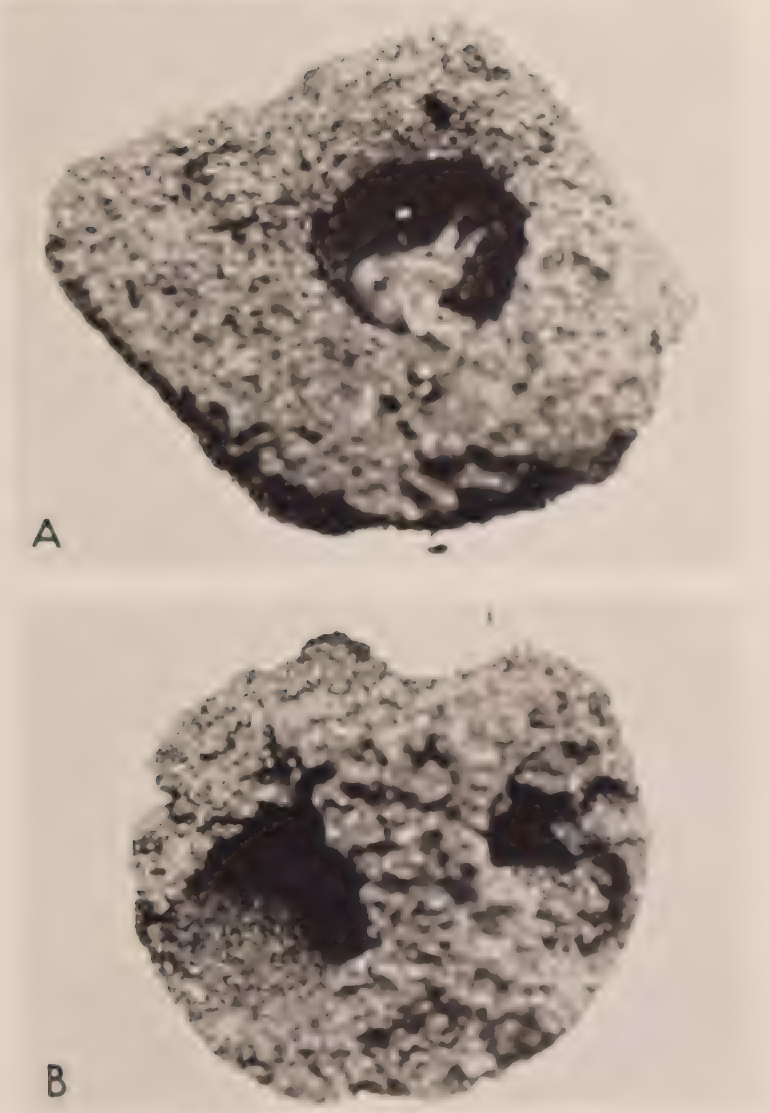
TABLE 30.—*Results of experiments in disking to prevent the transformation of curculio larvae to adults in the soil, Fort Valley, Ga., 1924*

Soil box No.	Number of larvae introduced	Date larvae introduced	Soil treatment	Weevils emerged		[illegible]
				Date	Number	
1	100	May 16	Disked [1] at 3-day intervals from May 19 to July 9.	[illegible]	[illegible]	[illegible]
2	100	...do....	Disked [1] at 6-day intervals from May 22 to July 9.	[illegible]	[illegible]	[illegible]
3	100	...do....	Disked [1] at 9-day intervals from May 25 to July 9	[illegible]	[illegible]	[illegible]
4	100	...do....	Disked [1] at 12-day intervals from May 28 to July 15.	[illegible]	[illegible]	[illegible]
5	100	...do....	Not disturbed; check	[illegible]	[illegible]	[illegible]

[1] Each disking was in a different direction from the preceding one.

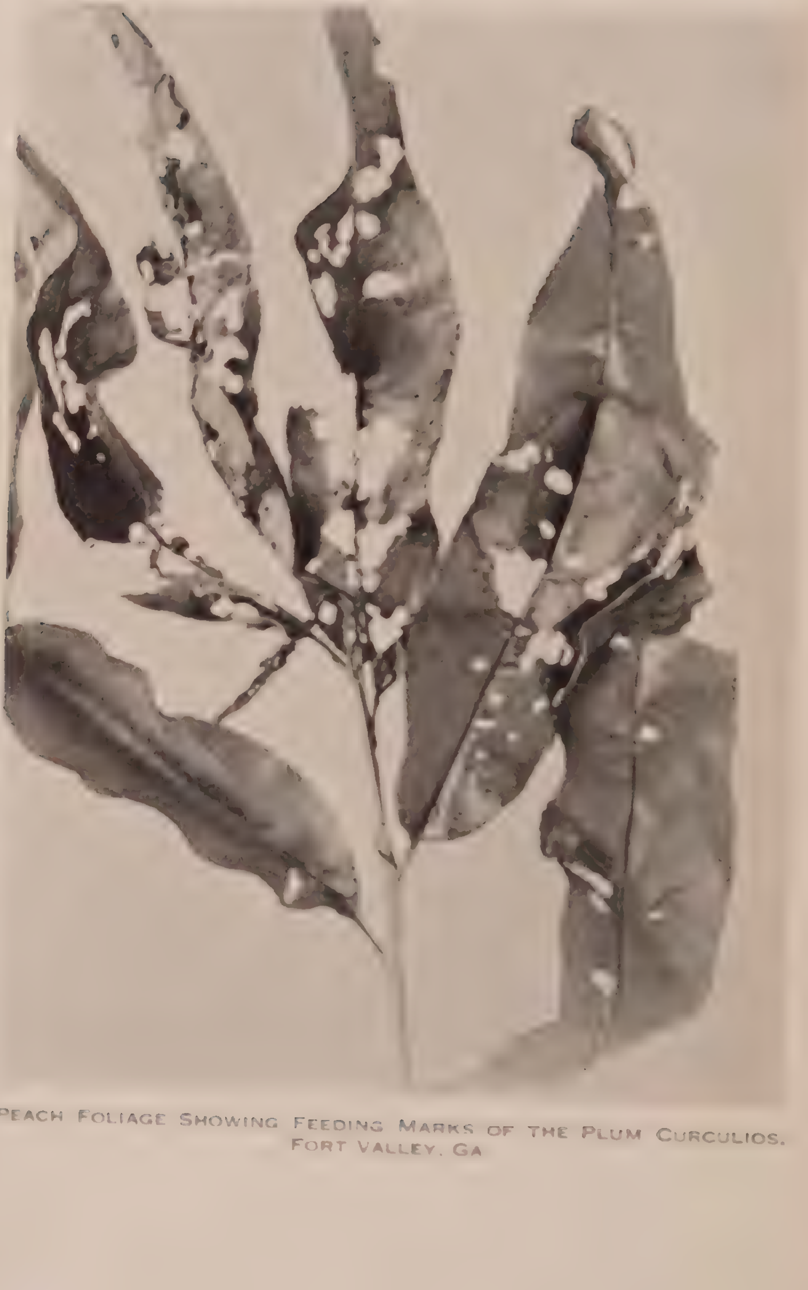
[2] By mistake a number of [illegible] larvae were used for this box, hence the low percentage of larvae transforming to adults.

[3] One parasite, *Triaspis curculionis*.


A
B

[illegible]

[illegible]



PEACH FOLIAGE SHOWING FEEDING MARKS OF THE PLUM CURCULIOS.
FORT VALLEY, GA.

Table 30 shows that the percentage of larvae transforming to beetles decreased with the frequency of the disking. Unfortunately a number of undersized larvae which never transform to adults were used by mistake in the check box. Therefore the percentage transforming in disked soil should not be compared with the percentage of larvae transforming to beetles in the check box.

In 1921 a number of pupae were taken from their soil cells and placed in loose dry soil; all of these died before transforming to adults. This experiment was duplicated at a later date. In this case the pupae were taken from their cells and placed on soil in a jar, and very dry, loose soil was then sprinkled over them. An examination a week later showed that all had died.

The adult curculios just after emerging are very soft. They are readily mashed when pressed between the fingers, whereas the old beetles break with a crackle when crushed. Ants have been observed attacking and killing adults that have just emerged from pupation boxes, both in the insectary and out of doors. Some of the beetles are darker than others upon emergence, showing that the period spent in the soil cell as an adult after pupation varies. Some of the newly emerged adults are very light brown.

THE ADULT

EMERGENCE OF BEETLES DURING THE FOUR YEARS

The first beetle to leave the soil in the insectary in 1921 emerged on May 29. Several pupae, which were found in the soil in an orchard on May 11, transformed to adults (pl. 7, D) on May 18, but they did not leave the soil until the latter part of the month. The new beetles fed very freely on peach foliage and fruit and on plums immediately after emergence and for some time before they started to oviposit. Copulation sometimes took place a few hours after emergence. For the purpose of obtaining longevity, oviposition, and other records, the beetles were placed in battery jars, the bottoms of which were covered with sand for several inches, and supplied with food. Moisture was supplied periodically. Care was taken not to keep these jars too moist, as fungous growth will soon kill the beetles if the jars are too wet. First-generation beetles emerged from the soil in large numbers during the period June 6 to 15 in 1921.

The first adult of the second generation in 1921 emerged on August 12 from a larva that reached maturity in a peach on July 13. The peach crop had been harvested before the second-generation adults started to emerge. They were supplied with apple fruit for food and fed readily upon it. Apples were also used to some extent for obtaining second-generation oviposition and larval records. The larvae developed in apples appeared as normal and as well matured as those developed in peaches; however, a longer time is required for a larva to reach maturity in an apple than in a peach. When foliage and fruit are placed in the jars the adults feed on both. They appear to use the foliage to rest under and upon as much as for food. The feeding on peach foliage is usually between the midrib and the margin, where irregular, usually circular-shaped holes are eaten out. (Pl. 9.) Fruit feeding is usually around where the fruit comes in contact with the resting surface, or on the upper side. The sides are seldom eaten, especially if apples are used for food. The smooth skin affords insufequate footing for side feeding. Much apple feeding is done on top of the fruit at the calyx or stem end.

None of the second-generation beetles oviposited in 1921, nor was any copulation of these beetles noted.

A few notes were made on stridulation of the curculio in 1921. A beetle that was audibly and violently stridulating was placed under the binocular microscope on its back. The beetle was in a typical sullen position, but the stridulation continued. The abdomen was observed to contract and expand very rapidly, while the rest of the body remained motionless. This was noted with several individuals. Beetles on their backs frequently move the tarsi up and down continually, but apparently this has no relation to stridulation.

The first adult of the first generation to leave the soil in 1922 emerged on May 29. On May 25 some fresh, reddish, new-looking adults were captured in the orchards. In all probability these were first-generation adults. The first pupa to transform to an adult in the insectary was noted on May 27.

For several days after emergence the newly emerged beetles apparently prefer fresh green peach foliage to fruit for food, as the foliage was usually riddled with feeding holes during that period, whereas there was not much feeding on the fruit. On June 16, 18 days after the first-generation beetles started to emerge, no copulation had taken place. The insects were observed for copulation at 10.30 p. m., but at that time they were all inactive. On the next night another examination was made when one pair was observed in copulation, the first to be recorded. At 3.30 a. m. on June 17 another examination was made, and all of the beetles were found to be inactive at that time of the morning.

An interesting note was made in 1922 on the development of a curculio. For four days a larva from a peach drop existed without soil in which to form a cell. As it finally transformed to the adult stage, there was full development of the head and legs, but the abdomen and wing covers never fully developed.

The first adult of the second generation to emerge from the soil in 1922 issued on July 27. This individual transformed to an adult in the pupal cell on July 22. The second-generation adults deposited a few third-generation eggs in 1922.

The only adult of the third generation to emerge from the soil in 1922 issued on October 7. This individual was reared from an egg deposited on August 18 and hatched on August 22, when it entered a peach. It reached maturity in the peach on September 11, when it left the fruit and entered the soil. It had transformed to a beetle in the soil by October 6 and emerged the following day.

Adult curculios were scarce in well-sprayed orchards at the close of the 1922 season. It was necessary to jar for 16 mornings during the latter part of September, in orchards that had been sprayed, in order to capture 2,400 beetles for hibernation studies. Of course, some of the beetles may have gone into hibernation by that time, but the thorough spraying was largely responsible for their scarcity.

The first-generation adults were late emerging from the soil in 1923. The first emergence was not recorded until June 7. The first transformation to the adult in the soil was noted on June 4. Fresh, clean, bright-colored adults of the first generation were captured in the field on June 8.

Only three adults of the second generation were reared in the insectary in 1923. These emerged on September 7, October 3 and 12. On account of the lateness of the emergence of first-generation adults in 1923, few, if any, second-generation adults occurred in the field.

On June 8 the first adult of the 1924 season emerged from the soil. On June 10 many adults of the first generation were taken in the field. They could be readily distinguished from the overwintered beetles by their bright color and their clean fresh appearance. The number of adults captured in the orchard jarred on June 16 was 76, as compared with 19 the week before. On June 19 the first pair of first-generation adults was taken in copulation.

Notes were taken in 1924 on the effect of the sun on recently emerged adults, and on the effect of dry soil on the escape of the adults from the soil after pupation. All of the beetles in three battery jars, supplied with a little foliage for food and shade, were dead after the battery jars had stood in the direct sun rays for a week. A number of adults died in the soil after transformation, unable to escape on account of the hard, dry soil. No water was added to the soil after these individuals pupated.

Even though the first-generation adults were as late leaving the soil in 1924 as in 1923, a sizable second generation occurred in 1924. In all probability this was due to the lateness of the peach-harvesting season, which was about two weeks later than in 1923. The first adult of the second generation emerged from the soil on August 24 in 1924. The heaviest emergence was during September and October, which was later than the heaviest emergence during 1921 and 1922, the other years when two generations occurred.

The hibernated beetles appeared in the orchards earlier in 1923 than in 1924 on account of the earlier season; and the first-generation adults would have emerged correspondingly earlier in 1923, if conditions had been more favorable during the transformation period in the soil. In all probability two broods of larvae would have then occurred before the close of the 1923 peach-harvesting season. As the fruit crop developed and matured more normally after full bloom in 1923 than did the crop of first-generation curculio adults, the fruit was off before a second brood was produced.

Table 31 gives a record of the emergence from the soil of first-generation adults during the years 1921 to 1924, inclusive.

TABLE 31.—*Emergence from the soil of first-generation plum-curculio beetles at Fort Valley, Ga., 1921–1924*

[illegible]	[illegible]			
	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		1		...
[illegible]				...
[illegible]	[illegible]	[illegible]		...
Total	[illegible]	[illegible]		...
June 1	[illegible]	[illegible]		
June 2	[illegible]	[illegible]		
June 3	[illegible]	[illegible]		
June 4	[illegible]	[illegible]		
June 5	[illegible]	[illegible]		
June 6	[illegible]	[illegible]		
June 7	[illegible]	[illegible]		
June 8	[illegible]	[illegible]	[illegible]	
June 9	[illegible]	[illegible]	[illegible]	
June 10	[illegible]	[illegible]	[illegible]	
June 11	[illegible]	[illegible]	[illegible]	
June 12	[illegible]	[illegible]	[illegible]	[illegible]
June 13	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]		[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			[illegible]	[illegible]
[illegible]			[illegible]	[illegible]
[illegible]			[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]
[illegible]			[illegible]	[illegible]
[illegible]			11	....

Date of emergence	[illegible]			
	[illegible]	[illegible]	[illegible]	[illegible]
July 13		[illegible]	[illegible]	1
July 14			[illegible]	1
July 15		[illegible]		1
July 16				
July 17			[illegible]	..
[illegible]		[illegible]	[illegible]	......
[illegible]			[illegible]	......
[illegible]				......
[illegible] 22				1
[illegible] 23				1
[illegible]			[illegible]	
[illegible] 25			[illegible]	[illegible]
[illegible] 26			[illegible]	
[illegible]			[illegible]	[illegible]
[illegible]		[illegible]		[illegible]
[illegible]	......	......	......	[illegible]
[illegible]	...	...	2	
[illegible] 31				[illegible]
Total	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]				[illegible]
[illegible]				[illegible]
[illegible]				[illegible]
[illegible]				[illegible]
[illegible]				[illegible]
[illegible]			[illegible]	
[illegible]		[illegible]		
[illegible]				
[illegible]		[illegible]		[illegible]
[illegible]				[illegible]
[illegible]				[illegible]
[illegible] 21				[illegible]
[illegible] 23				[illegible]
[illegible] 25	......	......	[illegible]	[illegible]
[illegible] 27				[illegible]
[illegible] 28				[illegible]
[illegible] 29				[illegible]
[illegible] 30				[illegible]
Total		[illegible]	[illegible]	[illegible]
[illegible] 1			[illegible]	[illegible]
[illegible] 2			[illegible]	[illegible]
[illegible] 3			[illegible]	
[illegible] 5			[illegible]	
[illegible] 8			[illegible]	
[illegible] 20			[illegible]	
Total			[illegible]	[illegible]

[illegible]	[illegible]							
	[illegible]		[illegible]		[illegible]		[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]				
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]				
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]
Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

June is the month of heaviest emergence of first-generation adults. In 1921 and 1922, when two large second generations occurred, 98.5 per cent of the first-generation beetles emerged during the month of June. In 1923, when the insect was single-brooded, 87.5 per cent emerged during June, and 11 per cent emerged during July. In 1924, 91 per cent emerged during June. The peach season was late in 1924, and two generations of the curculio occurred.

Table 32 gives a record of the emergence from the soil of second-generation adults during the years 1921 to 1924, inclusive.

TABLE 32.—*Emergence from the soil of second-generation [illegible] beetles at Fort Valley, Ga., 1921–1924*

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

In 1921, when two full generations occurred, 55 per cent of the second-generation adults emerged in August and 45 per cent in September. In 1922, when two full generations and several individuals of a third generation occurred, 72 per cent of the second-generation adults emerged in August and 20 per cent in September. A few emerged in July and October. Three individuals of a second generation were reared in the insectary in 1923, when the insect was single-brooded in the field; one of them emerged in September and two in October. In 1924, when the peach season was late, and when two generations of the curculio occurred, only 5 per cent of the second-generation adults emerged in August, 55 per cent in September, and 40 per cent in October.

LONGEVITY OF ADULT CURCULIOS

Many records were made during the four years on the longevity of the beetles captured in the field and of the first and second generation beetles reared in the insectary. The longest longevity record obtained was that of an individual of the second generation of 1922, which lived through two winters. It copulated with an individual of the second 1922 generation on March 16, 1923, and deposited eggs during 1923. The male of this pair died on August 30, 1923, whereas the female lived to June 16, 1924.

Table 33 gives a summarized record of the longevity of the adult beetles captured in the orchard by jarring during the 1921 season.

TABLE 33.—*Summary of longevity records of plum curculios captured in orchard by jarring during 1921 at Fort Valley, Ga.*

Time of capture	Number of beetles caught	Number of beetles alive on—							Percentage of beetles dying during—								[illegible]	[illegible]
		Apr. 30	May 31	June 30	July 31	Aug. 31	Sept. 30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
March	100	30	26	23	20	15	12	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
April	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
May	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
June	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
July	[illegible]				[illegible]	[illegible]	[illegible]	[illegible]				[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
August	[illegible]					[illegible]	[illegible]	[illegible]					[illegible]	[illegible]				[illegible]

[1] All live beetles placed in hibernation on Oct. 6.

[2] A number died as a result of fungus in jar.

Table 33 shows that most of the beetles captured in the orchard during March, April, and May died before fall. Very few, if any, of the beetles that entered hibernation from the collections of these three months survived the following winter. By June, first-generation beetles of the current season were being captured in the orchards and 18.1 per cent of the beetles taken in June, 27 per cent of those captured in July, and 50 per cent of those captured in August went into hibernation in the fall. The few beetles that were alive in July from the collection of March 21 appeared to be as active as the first-generation beetles.

An experiment was conducted in 1921 to ascertain how long adult curculios could survive without food. This experiment was conducted with 30 beetles, 15 of which were confined without food on August 10 and 15 without food on August 26. Table 34 gives the results of this experiment.

TABLE 34.—*Longevity of plum-curculio beetles confined without food, Fort Valley, Ga., 1921*

Date collected and confined	Number of beetles confined	Number of beetles alive on—													
		Aug. 13	Aug. 16	Aug. 19	Aug. 22	Aug. 24	Aug. 26	Aug. 29	Sept. 2	Sept. 6	Sept. 8	Sept. 11	Sept. 13	Sept. 15	Sept. 17
Aug. 10	15	15	8	6	4	3	2	1	0						
Aug. 26	15							15	10	6	6	3	2	1	1
		Percentage of beetles dying in specified number of days after confinement													
		3	6	7	9	11	12	13	14	16	18	19	20	22	23
Aug. 10	15	0.0	46.6		13.3		13.3		6.7	6.7		6.7			6.7
Aug. 26	15	0.0	.	33.3	...	40.0		0.0			6.7		6.7	6.7	.

In 1922 longevity records were taken on beetles captured in the orchard by jarring during the season and on both first and second generation beetles reared in the insectary. (Table 35.)

TABLE 35.—*Summary of longevity records of plum curculios captured in orchards by jarring during 1922 at Fort Valley, Ga.*

Time of capture	Number of beetles confined	Number of beetles alive on—						Percentage of beetles dying during—						Per cent entered hibernation Sept. 14
		Apr. 30	May 31	June 30	July 31	Aug. 31	Sept. 14[1]	April	May	June	July	August	September	
March	100	55	1	0	......	......	......	45.0	54.0	1.0	......	......	......	......
April	514	380	33	0	......	......	......	26.1	67.5	6.4				
May	457	......	334	54	14	2	2	......	26.9	61.3	8.8	2.6		0.4
June	1,112	......	......	631	[2] 223	47	46	......	......	43.3	[2] 36.7	15.9	0.1	4.1

[1] All live beetles placed in hibernation on Sept. 14.
[2] A number killed by fungus in jar.

The beetles taken in the orchards during March and April died before July; these were all beetles that had hibernated. Only 0.4 per cent of those captured during May entered hibernation in the fall; most of these, if not all, were also hibernated beetles. Of the beetles captured during June, 4.1 per cent entered hibernation; some of these may have been of the first generation of 1922.

The longevity records of 1,530 first-generation adult curculios that were reared in the insectary during 1922 may be summarized as follows: Of the 13 beetles that emerged late in May, 6 beetles (46.2 per cent) died during June, and 7 beetles (53.8 per cent), alive on September 27, were placed in hibernation. Of the 1,517 beetles that emerged in June, 1,461 were alive on June 30, 1,418 on July 31, 1,151 on August 31, and 1,045, alive on September 27, were placed in hibernation. The percentages that died during June, July, August, and September were 3.7, 2.8, 17.6, and 7, respectively, and 68.9 per cent entered hibernation.

Table 36 gives the records of longevity of second-generation adult curculios that were reared in the insectary during 1922.

TABLE 36.—*Longevity of second-generation plum curculios reared in the insectary during 1922 at Fort Valley, Ga.*

Time of emergence	Number of beetles	Number of beetles alive on—		Percentage of beetles dying during—		Percentage of beetles entering hibernation
		Aug. 31	Sept. 27[1]	August	September	
July 27 to Aug. 3	18	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Aug. 4 to 11	21	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Aug. 12 to 19	45	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Aug. 20 to 25	28	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Aug. 26 to 31	26	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total	136	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Sept. 1 to 10	28		[illegible]		[illegible]	[illegible]
Sept. 11 to 20	18		[illegible]		[illegible]	[illegible]
[illegible]	[illegible]		[illegible]		[illegible]	[illegible]
Total	84		[illegible]		[illegible]	[illegible]

[1] All live beetles placed in hibernation on Sept. 27.

In 1923 longevity records were taken on the beetles captured in the orchard by jarring during the season, on those reared in the insectary, and on the first and second generation beetles of 1922 that emerged from hibernation. As there was no second generation in 1923, no longevity records are available for that generation.

Table 37 gives a summary of the longevity records of adult beetles captured in the orchard by jarring. All of the beetles captured during March, April, and May had overwintered. The majority of those taken during June, July, and August entered hibernation.

TABLE 37.—*Summary of longevity records of plum curculios captured in orchard by jarring during 1923 at Fort Valley, Ga.*

Time of capture	Number of beetles	Number of beetles alive on—						Percentage of beetles dying during—						Percentage of beetles entering hibernation
		Mar. 31	Apr. 30	May 31	June 30	July 31	Aug. 30[1]	March	April	May	June	July	August	
March	85	82	66	63	21	0		3.5	18.8	3.5	49.4	[illegible]		[illegible]
April	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
May	61			33	7	0				45.9	42.6	[illegible]		[illegible]
June	261				241	186	186				7.7	[illegible]	[illegible]	[illegible]
July	168					147	126					12.5	12.1	[illegible]
August	13						13							[illegible]

[1] [illegible]

[2] [illegible]

[3] [illegible]

Table 38 gives a summary of the longevity records of first-generation adults that were reared in the insectary during 1923. Most of these entered hibernation.

TABLE 38.—*Summary of longevity records of first-generation plum curculios reared in the insectary during 1923 at Fort Valley, Ga.*

Time of emergence	Number of beetles	Number of beetles alive on—			Percentage of beetles dying during—			Percentage of beetles entering hibernation
		June 30	July 31	Aug. 30[1]	June	July	August	
June	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
July	[illegible]		[illegible]	[illegible]		[illegible]	[illegible]	[illegible]

[1] All live beetles placed in hibernation on Aug. 30.

Table 39 gives a summary of the longevity records during 1923 of curculios reared in the insectary in 1922.

TABLE 39.—*Longevity of plum curculios of 1922 that appeared from hibernation in 1923 at Fort Valley, Ga.*

Generation of 1922	Time of appearance	Number of beetles	Number of beetles alive on— Mar. 31	Apr. 30	May 31	June 30	July 31	Aug. 31[1]	Percentage of beetles dying during— March	April	May	June	July	August	Percentage of beetles entering hibernation second winter
First	March	118	116	99	58	20	10	9	1.7	14.4	34.7	32.2	8.5	0.8	7.6
Do.	April	84	.....	77	51	22	4	2		8.3	31.0	34.5	21.4	2.4	2.4
Second	March and April	21	.....	21	16	12	9	7			23.8	19.0	14.3	9.5	33.3

[1] All live beetles placed in hibernation on Aug. 31.

These records show that some of the first-generation beetles of 1922 entered hibernation the second winter. However, none of these individuals survived the second winter.

Of the second-generation beetles of 1922 that appeared from hibernation during March and April, 1923, 33.3 per cent entered hibernation the second winter. One female survived the second winter and lived nearly two years. This individual deposited eggs during 1923, but no eggs were recorded from it in 1922 or 1924.

Longevity records are available for 1924 on the first-generation adults reared in the insectary that year, and on the first-generation beetles of 1923 that emerged from hibernation in 1924.

Table 40 gives a summary of the longevity records of the first-generation adults that were reared in the insectary during 1924. Most of them entered hibernation.

TABLE 40.—*Summary of longevity records of first-generation plum curculios reared in the insectary during 1924 at Fort Valley, Ga.*

Time of emergence	Number of beetles	Number of beetles alive on— June 30	July 31	Aug. 31	Sept. 15[1]	Percentage of beetles dying during— June	July	August	September	Percentage of beetles entering hibernation
June	939	897	786	737	706	4.5	11.8	5.2	3.3	75.2
July	[illegible]		[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]

[1] All live beetles placed in hibernation on Sept. 15.

Table 41 gives a summary of the longevity records during 1924 of first-generation adults that were reared in the insectary in 1923.

TABLE 41.—*Longevity of first-generation plum curculios of 1923 that appeared from hibernation in 1924 at Fort Valley, Ga.*

Time of appearance	Number of beetles	Number of beetles alive on— Mar. 31	Apr. 30	May 31	June 30	July 31	Aug. 31	Sept. 30[1]	Percentage of beetles dying during— March	April	May	June	July	August	September	Percentage of beetles entering hibernation second winter
March	30	29	20	4	0	.....	.....	.....	3.3	30.0	53.3	13.3	.....	.....	.....	0.0
April	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
May	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]				[illegible]	[illegible]	[illegible]	[illegible]	.....	[illegible]

[1] All live beetles placed in hibernation on Sept. 30.

HIBERNATION

Many observations on the hibernating habits of the plum curculio in Georgia were made during the four years that this insect was studied. Their favorite hibernating quarters are leaves, sticks, trash, etc., along the edges of woodlands adjoining or near the peach orchard. Bermuda and other grasses also furnish very favorable protection, and undoubtedly many beetles hibernate in it under trees, along fence rows, and on terrace rows in and near the orchard. Records were made in 1921 on the time the beetles entered hibernation, the depth of hibernation, and mortality during hibernation in the fall. In 1923, 1924, and 1925 records were taken on the mortality of beetles during the previous winters in the different kinds of hibernating materials that are usually found in and near peach orchards.

Table 42 gives a number of records on the time of the year that the adult curculios entered hibernation in 1921.

TABLE 42.—*Time beetles entered hibernation in the fall of 1921, in cages containing rubbish, Fort Valley, Ga.*

Test No.	Beetles or food placed in cage	Beetles	Food supplied	Date cage was examined	[illegible]	[illegible]	
		Number			Number	Number	Per cent
	Aug. 16	40	Peach foliage	Aug. [illegible]	[illegible]		
1	Aug. 22		do	Aug. 23	10	1	2.5
				[illegible]	[illegible]		
				[illegible]			
	Aug. 26	44	Peach foliage	Sept. 2	33		
	Sept. 6	33	Peach foliage and apples	Sept. [illegible]	[illegible]		
2	Sept. 15	4	Peach foliage	Sept. 15	4	27	61.4
				Sept. 22	17		
	Aug. 16	50	Peach foliage	Aug. [illegible]	[illegible]		
3	Aug. 21		do	Aug. 23	11	[illegible]	[illegible]
	Sept. 6	43	do	Sept. 15	14		
	Sept. 17		[illegible]	[illegible]	[illegible]		
	Aug. 16	50	do	Aug. [illegible]	[illegible]		
4	Aug. 21		do	Aug. 30	5	6	[illegible]
				Sept. 2	0		
5	Sept. 6	43	Peach foliage and apples	[illegible]	[illegible]	[illegible]	[illegible]
	Aug. 16	50	do	Aug. 30	38		
6	Aug. 30		do	[illegible]	[illegible]	7	[illegible]
				Sept. 6	1		
	Sept. 6	[illegible]	Peach foliage and apples				
7	Sept. 8		do	Sept. 15	26	[illegible]	[illegible]
	Sept. 20		Peach foliage	Sept. 21	7		
				Sept. 22	1		
	Sept. 4	200	Peach foliage	Sept. 9	173		
	Sept. 7		do	Sept. 10	46		
8	Sept. 9		do	Sept. 12	9	[illegible]	[illegible]
				Sept. 15	5		
				[illegible]			
	Sept. 7	250	Peach foliage	Sept. 12	158		
9				Sept. 13	61	[illegible]	[illegible]
				Sept. 14	10		
				Sept. 15	5		

In the second test the 44 beetles were placed in the cage on August 26, and 33 were recovered on September 2. After another examination on September 6 the 33 beetles were put back in the cage. On September 15, 4 were recovered and returned to the cage. On September 22, when the cage was examined, 17 beetles were recovered on top of the rubbish and 27 (or 61.4 per cent) were found in hibernation.

In the third test the 50 beetles were placed in the cage on August 16 and the 43 that were recovered were put back in the cage on September 6.

The data in Table 42 would lead one to believe that in 1921 the beetles were entering hibernation in numbers between September 15 and 22.

Table 43 gives data on the mortality of the curculio in hibernation during the fall months and the depth of hibernation. The data on depth of hibernation were taken by carefully examining sections of the soil blocks in the hibernating cages. (Pl. 4, B.)

TABLE 43.—*Mortality of adult plum curculios during hibernation, and depth of hibernation, Fort Valley, Ga., 1921*

Date beetles were placed in hibernation	Number of beetles	Number of beetles in hibernation Nov. 28, 1921, located [1]—			Percentage of hibernating beetles found—			Percentage of mortality during fall
		In foliage on soil	On soil surface	Within first inch of soil	In dried foliage	On soil surface under foliage	Within first inch of soil	
Oct. 12	102	41	23	13	53.2	29.9	16.9	24.5
Do.	46	[2] 14	10	10	41.2	29.4	29.4	26.1

[1] No beetles found in second, third, or fourth inch under surface.
[2] Noted on Dec. 2.

In these two tests the average mortality of the beetles between October 12 and December 2 was 25 per cent. Of the beetles in hibernation on November 28, an average of 47.2 per cent were in the dried foliage, 29.7 per cent on the soil surface under the foliage, and 23.2 per cent within the first inch of soil.

Table 44 gives some data on the depth of hibernation of the curculio during the winter of 1921–22. The observations were made on March 4, 1922.

TABLE 44.—*Depth of hibernation of plum curculios, winter of 1921–22, Fort Valley, Ga.*

Cage No.	Placed in hibernation cages	Date of removal of beetles	Number of beetles removed from [1]—			Percentage of beetles hibernating—		
			Foliage on surface	Soil surface	Within first inch of soil	In dried foliage	On soil surface under foliage	Within first inch of soil
1	Fall, 1921	Mar. 4, 1922	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	Do.	Do.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[1] No beetles found in second, third, or fourth inch under surface.

An average of 88.7 per cent of the beetles placed in hibernation in the fall of 1921 were in the dried foliage in the cages on March 4, 1922, an average of 9.1 per cent were on the soil surface under the foliage, and an average of 2.2 per cent were within the first inch of soil.

On September 19, 1922, 400 curculios were placed in each of six large hibernating cages (pl. 4, A), containing the different kinds of hibernating materials commonly found near and in Georgia peach orchards. Notes were taken on the emergence of the beetles during the spring of 1923, and from this the percentage of the beetles surviving the winter was calculated for the several cages. (Table 45.)

TABLE 45.—*Wintering of plum curculios during winter of 1922–23 in different kinds of hibernating material at Fort Valley, Ga.*

Hibernating material [1]	Beetles placed in hibernation		Number of beetles appearing during 1923 in—			Percentage of emerging beetles appearing in—			Percentage of beetles surviving winter
	Date	Number	March	April	May	March	April	May	
Bare ground	Sept. 19	400	[2] 21	8	0	72.4	27.6	0.0	7.25
Spanish moss	do.	400	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pine needles	do.	400	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Trash (sticks, bark, pine cones, etc.)	do.	400	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Leaves	do.	400	186	68	3	72.4	26.4	1.2	64.25
Bermuda grass	do.	400	207	78	10	70.2	26.4	3.4	73.75
Average						72.9	25.7	1.4	43.00

[1] All hibernating materials were exposed to the weather.

[2] Many dead beetles found on top of ground.

Bermuda grass furnished the best protection during the winter of 1922–23, followed by leaves, Spanish moss, pine needles, trash, and bare ground.

Most of the beetles die during the winter if no hibernating material is available. Probably some few get under loose particles of soil. The data given in Tables 43 and 44 support this opinion, as does also the survival during the winter of 1922–23 in the cage containing bare ground. (Table 45.)

Of the beetles from all the cages used in the above experiment, 72.9 per cent appeared from hibernation during March, 25.7 per cent appeared during April, and 1.4 per cent during May.

It will be noted from Table 45 that the highest March emergence was from the cage containing trash, such as sticks, bark, pine cones, etc. The proportion that emerged in this cage during March as compared with later months was much greater than in the other cages. This is probably due to the fact that these materials dry out and warm up earlier than the other materials, thereby causing the beetles to leave hibernation in this cage in greater numbers early in the season.

While the beetles in the above experiment were placed in the hibernation cages on September 19, there was considerable activity on the part of the curculios in some of the cages after that date, on account of abnormally high temperatures. The maximum temperature on November 14, 1922, was 76° F. On that date a number of beetles were observed crawling on the screen sides of several cages. These were counted, and the numbers found crawling around inside of the several cages were as follows: Bare-ground cage, 52; Spanish-moss cage, 0; pine-needle cage, 3; trash cage, 8; leaves cage, 8; Bermuda-grass cage, 0.

During the winter of 1922–23 an experiment was conducted to determine the winter survival of adult beetles in Spanish moss under shelter in the insectary. Most of the beetles were placed in the cages on September 27, 1922, and emergence records were taken during the following March and April. Table 46 gives the results.

TABLE 46.—*Mortality of plum curculios during winter of 1922–23 in Spanish moss under shelter at Fort Valley, Ga.*

Beetles placed in hibernation			Number of beetles appearing during 1923 in—		Percentage of emerging beetles appearing in—		Percentage of beetles surviving winter
Date	Number	Generation	March	April[1]	March	April	
Sept. 27	100	First	9	4	69.2	30.8	13.0
Do	100	do	6	1	85.7	14.3	7.0
Do	100	do	50	11	82.0	18.0	55.5
Sept. 29 to Oct. 20	10	Second					
Sept. 27	125	First	25	1	96.2	3.8	20.8
Do	125	do	34	20	63.0	37.0	43.2
Do	125	do	62	23	72.9	27.1	68.0
Do	125	do	51	22	69.9	30.1	58.4
Do	125	do	63	31	67.0	33.0	75.2
Do	125	do	63	14	81.8	18.2	61.6
Do	100	Second	30	19	61.2	38.8	49.0
Sept. 27 to Oct. 24	100	do	2	0	100.0	0.0	2.0
[illegible]	1	Third					
Average					72.6	27.4	41.8

[1] All cages opened on Apr. 21 and remaining beetles removed.

The average percentage of beetles surviving the winter of 1922–23 in Spanish moss under shelter was 41.8; in Spanish moss in the open, exposed to rains, etc., 49.75 per cent.

On August 30, 1923, beetles were placed in large cages containing Bermuda grass, leaves, and bare ground for data on the mortality during the winter of 1923–24. Records on the emergence from these cages were taken during March and April, 1924. The mortality in hibernation was higher than during the other winters that the studies were under way. This was probably due to the abnormally low temperatures that prevailed, which undoubtedly affect the abundance of the insect each spring. A minimum temperature of 7° F. was recorded at Fort Valley at one time during the winter of 1923–24. Table 47 gives the percentage of the beetles that survived.

TABLE 47.—*Mortality of plum curculios during winter of 1923–24 in cages containing different kinds of hibernating materials at Fort Valley, Ga.*

Hibernating material[1]	Beetles placed in hibernation		Number of beetles appearing during 1924 in—		Percentage of emerging beetles appearing in—		Percentage of beetles surviving winter
	Date	Number	March	April	March	April	
Bare ground	Aug. 30	338	1	0	100.0	0.0	0.3
Leaves	do	400	19	27	41.3	58.7	11.5
Bermuda grass	do Sept. 3 to Oct. 6	421 69	81	171	32.1	67.9	51.4
Average					33.8	66.2	24.3

[1] All hibernating materials were exposed to the weather.

Again Bermuda grass furnished the best protection. The winter survival in Bermuda grass was 31.4 per cent, as compared with 11.5 per cent for leaves and 0.2 per cent for bare ground. Only 1 beetle of the 535 in the cage with no hibernating material survived the severe winter. The beetles were late leaving hibernation in numbers during the spring of 1924, as only 33.8 per cent appeared during March whereas 66.2 per cent appeared during April. The cold winter may have influenced the lateness of emergence also.

The winter of 1923–24 was the second winter that one individual curculio survived, as already mentioned. All of the other beetles of the first and second generations of 1923 that were placed in hibernation in the fall of 1923 died during the winter.

On September 15, 1924, a number of adult curculios were placed in large cages containing Bermuda grass, pine needles, oak leaves, and bare ground to obtain data on the mortality during the winter of 1924–25. Emergence from hibernation records were taken on each cage during March and April, 1925. Peach blossoms were placed in the cages on March 2, and the first appearance from hibernation was recorded on March 4. Table 48 gives the percentage of the beetles that survived the winter in the several kinds of hibernating materials. Bermuda grass again gave the best protection.

TABLE 48.—*Mortality of plum curculios during the winter of 1924–25 in different kinds of hibernating materials at Fort Valley, Ga.*

Hibernating material[1]	Beetles placed in hibernation		Number of beetles appearing during 1925 in—		Percentage of emerging beetles appearing in—		[illegible]
	Date	Number	March	April	March	April	[illegible]
Oak leaves	Sept. 15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Bare ground	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pine needles	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Bermuda grass	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Average					81.9	18.1	[illegible]

---

[1] All hibernating materials were exposed to the weather.

The average percentage of emerging beetles appearing from hibernation during March was 81.9 as compared with 18.1 for April. This would indicate that the beetles left hibernation in numbers early during the spring of 1925.

TIME REQUIRED FOR TRANSFORMATION FROM EGG TO ADULT

During the 1922 season four individuals of the first generation and two of the second generation were under careful observation from the time the eggs were deposited until the adults emerged, in order to determine the length of time required for the different stages by the same individual in passing through the entire life cycle. Table 49 gives the results of these observations.

Table 49.—*Time spent by four first-generation and two second-generation plum curculios in passing through their entire life cycle at Fort Valley, Ga., [illegible]*

Generation	Individual No.	Egg deposited	Egg hatched	Larva left fruit	Larva pupated	Pupa transformed to adult	Adult left soil	Time in fruit as egg	Time in fruit as larva	Time in soil as larva	Time in soil as pupa	Time in soil as adult	Length of life cycle
								Days	*Days*	*Days*	*Days*	*Days*	*Days*
First	1	[illegible]	[illegible]	June 5	[illegible]	[illegible]	[illegible]	4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	2	May 17	May 23	do	June 21	June 30	July 7	6	13	16	9	7	51
Do	3	May 25	May 28	June 10	do	do	July 5	3	13	11	9	5	41
Do	4	do	May 31	June 14	June 30	July 4	July 11	6	14	16	4	7	47
Average								4.75	13	13.5	7.75	[illegible]	[illegible]
Second	1	June 16	June 19	June 29	July 12	July 20	July 23	3	10	13	8	3	37
Do	2	do	June 20	July 1			Aug 1	4	11				46
Average								3.5	10.5				41.5

The weather conditions, time of year, and number of individuals materially affect the average time spent in the fruit and in the soil during the life cycle of the curculio. Table 50 gives the average time required for the complete transformations of the plum curculio, as shown separately in preceding pages. This table should not be used to correlate the number of generations during the several years with the length of time spent in the several stages or to compare the time required to complete the life cycle with climatic conditions, as it does not give the monthly averages, but only the averages for the entire season. It should serve, however, to give an idea of the time required for the curculio to pass through its life cycle.

Table 50.—*Time required for the complete transformation of the plum curculio at Fort Valley, Ga., 1922–1924*

Season	Average time spent in fruit as egg and larva		Average time spent in soil as larva, pupa, and adult		Average length of period of complete transformation	
	First generation	Second generation	First generation	Second generation	First generation	Second generation
	Days	*Days*	*Days*	*Days*	*Days*	*Days*
1922	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1923	17.90	[1] 14.00	37.46	[1] 32.33	55.36	[1] 46.33
1924	[2] 16.00	[3] 17.00	31.62	[3] 32.85	[2] 47.62	[3] 49.85
Average	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[1] Records on only a few individuals.

[2] No April records included.

[3] A number of September records included.

The first generation passed through its life cycle in an average of about 52 days and the second generation probably requires an average of about 48 days to complete its life cycle. The first generation spends about 18 days in the fruit as egg and larva and about 34 days in the ground as larva, pupa, and adult. The second generation spends about 17 days in the fruit as egg and larva and about 29 days in the ground as larva, pupa, and adult. The data for the second generation in 1924 include a number of September records. The time required for each stage of the second generation during September is much greater than that required during midsummer. On this account the average time required for the second generation to complete its transformation during the entire season of 1924 is much longer than the averages for the other second generations. This also raised the average time for complete transformation for the three seasons.

The average time spent in the fruit as egg and larva by the first generation in 1924 does not include any records for April. April records would undoubtedly raise the average time required for the complete transformation of the first generation in 1924.

Table 30 shows that the average time required for the first generation to complete its transformation in 1921, when there was only one generation, was only 1.21 days more than in 1922, when two and part of a third generation occurred. It must be remembered, however, that these averages are for the season. The average time spent in the soil as larva, pupa, and adult combined, by individuals entering the soil during May, 1923, was 43.4 days, as compared with 37.5 days for the season. The averages for June, July, and August entrants materially lowered the average for the season. The length of time spent in the soil by those entering in May, 1923, may have been responsible for the single brood in 1923, as the emergence of first-generation adults that year was probably delayed until after the harvest of the fruit.

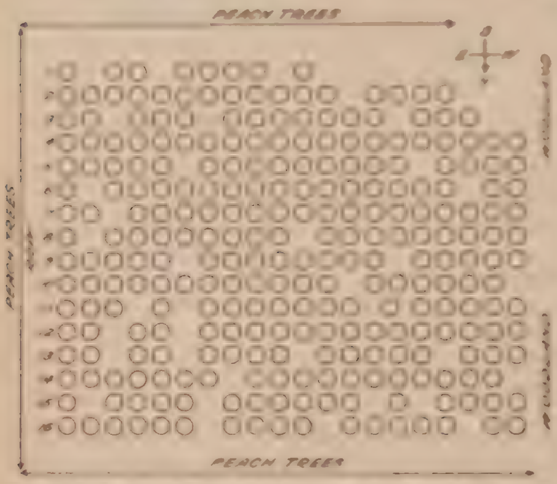


FIGURE 1.—Diagram of block in a bearing orchard used for jarring throughout the season of 1921

OCCURRENCE OF BEETLES IN ORCHARDS THROUGHOUT THE SEASONS OF 1921 TO 1924, INCLUSIVE

In order to obtain some data on the abundance of the curculio in the orchards throughout the seasons that these life-history studies were under way, on the first appearance of the beetles in the orchard, on the distribution of the beetles in the orchard early in the season, on the appearance and abundance of the beetles with reference to the condition of the trees, and on the last occurrence of beetles in the orchard, a number of trees were jarred regularly during the four years, as described on page 5 and illustrated in Plate 3, A. These records were also used for correlation with the development in the insectary.

JARRING RECORDS OF 1921

The block in a bearing orchard used for jarring throughout the season of 1921 was bounded on one side by a strip of woods and on three sides by a continuation of the peach orchard. (Fig. 1.) Sixteen rows in which were 270 trees were jarred from March 4 to March

31, and from then until October 15 only the first eight rows in which were 152 trees were jarred.

Table 51 summarizes the results of the jarring of trees in the first eight rows of block 3 in this orchard from March 4 to October 15, 1921.

TABLE 51.—*Number of plum curculios collected by jarring the trees in eight rows of block 3 in a peach orchard, Fort Valley, Ga., 1921*

Date of jarring [1]	Number of curculios	Date of jarring [1]	Number of curculios	Date of jarring [1]	Number of curculios	Date of jarring [1]	Number of curculios
Mar. [illegible]	1	Apr. 28	20	June 24	717	Aug. 24	9
Mar. [illegible]	36	Apr. 30	28	June 27	893	Aug. 26	11
Mar. [illegible]	174	May 3	9	June 29	427	Aug. 29	1
Mar. [illegible]	43	May 6	16	July 2	376	Aug. 31	3
Mar. 14 [3]	602	May 9	16	July 5	180	Sept. 2	2
Mar. 15	521	May 11	15	July 7	164	Sept. 7	2
Mar. 17	712	May 14	21	July 9	164	Sept. 9	1
Mar. [illegible]	981	May 18	21	July 12	117	Sept. 12	1
Mar. [illegible]	1,040	May 21	13	July 15	79	Sept. 15	1
Mar. [illegible]	270	May 23	16	July 18	113	Sept. 17	2
Mar. [illegible]	432	May 26	60	July 20	103	Sept. 19	11
Mar. 28	442	May 28	53	July 25	39	Sept. 21	4
Mar. 30	65	May 31	81	July 27	44	Sept. 23	4
Apr. 2	43	June 2	116	July 29	58	Sept. 26	6
Apr. 4	119	June 4	153	Aug. 1	63	Sept. 28	3
Apr. 6	101	June 6	167	Aug. 3	40	Oct. 1	4
Apr. 8	109	June 8	138	Aug. 5	10	Oct. 4	3
Apr. [illegible]	2	June 10	173	Aug. 8	14	Oct. 7	1
Apr. [illegible]	3	June [illegible]	[illegible]	Aug. [illegible]	[illegible]		
Apr. [illegible]	4	June 15	161	Aug. 12	13	Total	10,317
Apr. [illegible]	6	June 17	180	Aug. 15	10		
Apr. 21	13	June 20	184	Aug. 19	3		
Apr. 26	30	June 23	186	Aug. 23	9		

CURCULIOS CAUGHT IN EACH ROW

Row No.	Number of curculios	Percentage of total	Row No.	Number of curculios	Percentage of total
1	1,069	10.36	6	1,0[illegible]	10.[illegible]
2	2,133	20.67	7	1,087	10.54
3	1,615	15.65	8	922	8.94
4	1,314	12.74			
5	1,105	10.71	Total	[7] 10,317	100.00

NOTE.—[illegible]

[1] [illegible]

[3] Rain. Only 6 rows jarred.

[5] Very windy and cold.

[6] Cold and frost.

[7] [illegible]

The first beetle captured in the orchard in 1921 was taken on March 4. No beetles occurred in this orchard after October 7. The peak of appearance from hibernation occurred on March 21. The peak of emergence of first-generation beetles was probably on June 27. There was an abrupt increase in the numbers captured around June 1, which was probably the time that the first-generation adults started to emerge. There was not a great deal of difference in the total number collected from each row; it ranged from 922 for row 8 to 2,133 for row 2.

In order to see if an asparagus bed would affect the abundance of the beetles on trees near it early in the season, and thereby determine whether it would furnish satisfactory conditions for hibernation, tr rows of peach trees were jarred in another portion of this same orchard. These 16 rows were away from any wooded area. On three sides this block was bounded by a continuation of the peach orchard; on the west side, running along the entire side of row 1, was an asparagus bed. The jarring was started in this block on March 7 and concluded on March 24. This period of jarring would show whether the asparagus bed was used for hibernation by the beetles. Table 52 gives a summary of the results of jarring in this block.

TABLE 52.—*Number of plum curculios collected by jarring the trees in block [illegible] in a peach orchard, Fort Valley, Ga., March 7 to 24, 1921*

Row No.	Number of curculios	Percentage of total	Row No.	Number of curculios	Percentage of total
1	941	14.4	10	[illegible]	[illegible]
2	849	13	11	[illegible]	[illegible]
3	475	7.2	12	[illegible]	[illegible]
4	481	7.3	13	[illegible]	[illegible]
5	394	6	14	[illegible]	[illegible]
6	325	5	15	[illegible]	[illegible]
7	[illegible]	[illegible]	16	[illegible]	[illegible]
8	275	4.2			
9	326	5	Total	6,552	100

A total of 6,552 beetles were captured on the 16 rows from March 7 to 24. The numbers captured on rows 1 and 2, those nearest the asparagus bed, were nearly twice as great as the numbers captured on any of the other rows. The numbers collected from rows 1 and 2 were 941 and 849, respectively, whereas the highest number collected from any other row was 481 on row 4. Of the total number of beetles collected from the 16 rows during the period, 27.4 per cent were taken from the first two rows. These records indicate that the asparagus bed alongside of row 1 harbored many adult curculios during the winter of 1920–21.

JARRING RECORDS OF 1922

The first beetles captured in an orchard by jarring in 1922 were captured on March 1 from the block of trees (fig. 11) used for jarring records throughout the previous season. These 16 rows, containing 270 trees, were jarred at intervals from March 1 to April 3, 1922, to compare the infestation of 1921 with that of 1922, and to obtain notes on the extent of emergence from hibernation during the month. (Table 53.)

TABLE 53.—*Number of plum curculios collected by jarring the trees in 16 rows in a peach orchard, Fort Valley, Ga., 1922*

Date of jarring	Number of curculios	Date of jarring	Number of curculios
Mar. 1	47	Mar. 22	[illegible]
Mar. 6	10	Mar. 24	[illegible]
Mar. 9	[illegible]	Mar. [illegible]	[illegible]
Mar. 11	30	Mar. 31	[illegible]
Mar. [illegible]	[illegible]	Apr. [illegible]	[illegible]
Mar. [illegible]	[illegible]		
Mar. 17	23	Total	[illegible]

TABLE 53.—*Number of plum curculios collected by jarring the trees in 16 rows in a peach orchard, Fort Valley, Ga., 1922*—Continued

CURCULIOS CAUGHT IN EACH ROW

Row No.	Number of curculios	Percentage of total	Row No.	Number of curculios	Percentage of total
1	90	13.1	9	16	2.4
2	184	28.4	10	11	1.6
3	118	17.2	11	14	2.[illegible]
4	64	9.9	12	3	[illegible]
5	44	6.8	13	16	2.4
6	53	7.7	14	14	2.[illegible]
7	[illegible]	[illegible]	15	[illegible]	[illegible]
8	15	2.3	16	6	[illegible]

Only 648 beetles were captured in this block during March, 1922, as compared with 9,230 from the same block during March, 1921. This shows a tremendous reduction in the infestation, indicating the effectiveness of the curculio suppression campaign of 1921. In addition to the hibernation quarters afforded by the wooded area at the end of each of the 16 tree rows, there must have been favorable hibernating quarters somewhere to the south of the block, as there were more beetles captured on the first three rows than on the others during the month. From the data in Table 52 the indications are that the peak of appearance from hibernation occurred about March 29.

The first 10 rows from the asparagus bed of the same portion (block 2) of an orchard jarred in 1921 were jarred again in 1922 to obtain information on the comparative infestations and to again determine if the asparagus bed afforded hibernation quarters for the insects during the winter months. Forty-seven trees, 30, 35, and 36 rows away from the asparagus bed, were also jarred to determine the infestation on those rows as compared with those near the bed. The first 10 rows that were jarred contained 158 trees. Table 54 gives a summary of the results.

TABLE 54.—*Number of plum curculios collected by jarring the trees in 13 rows in a peach orchard, Fort Valley, Ga., March 6 to April 3, 1922*

Row No.	Number of curculios	Percentage of total	Row No.	Number of curculios	Percentage of total
1	[illegible]	[illegible]	9	[illegible]	[illegible]
2	[illegible]	[illegible]	10	[illegible]	[illegible]
3	[illegible]	[illegible]	30	[illegible]	[illegible]
4	[illegible]	[illegible]	35	[illegible]	[illegible]
5	[illegible]	[illegible]	36	[illegible]	[illegible]
6	[illegible]	[illegible]	Total	[illegible]	100
7	[illegible]	[illegible]			
8	[illegible]	[illegible]			

This record again shows that the asparagus bed probably offered favorable hibernating quarters for the curculio, as more were captured during March on the rows nearest the bed. The asparagus bed adjoined row 1 along its entire length. Only five beetles were captured during the month on rows 30, 35, and 36 away from the bed. The records indicate that there was a large reduction in the curculio infestation in this orchard in 1922 as compared with 1921, which further supports the effectiveness of the curculio suppression campaign of 1921.

The block of trees used for jarring throughout the season of 1922 was some distance from the orchard used for jarring throughout the previous season. The block used in 1922 consisted of 117 bearing trees of the Hiley variety. Jarring was started in this orchard on March 16 and continued until August 22. The block was bounded on the north by a piece of woodland. There was also a woodland some distance to the west of the block. A continuation of the peach orchard bounded the block on the east and south. (Fig. 2.)

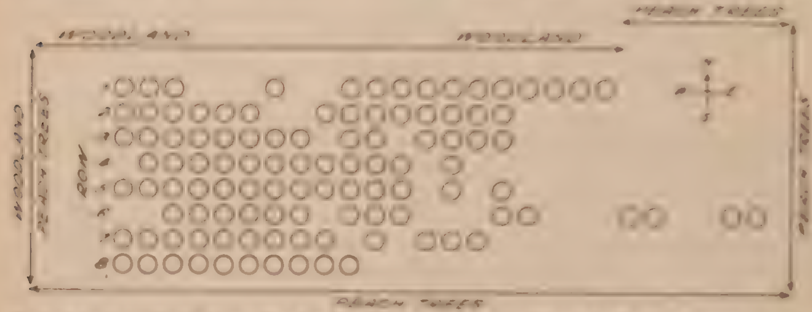


FIGURE 2.—Location of trees [illegible]

Table 55 gives a summary of the results of the jarring in this orchard from March 16 to August 22.

TABLE 55.—Number of plum curculios collected by jarring the trees in eight rows in a Hiley peach orchard, Fort Valley, Ga., 1922

Date of jarring	Number of curculios	Date of jarring	Number of curculios	Date of jarring	Number of curculios	Date of jarring	Number of curculios
Mar. 16	208	Apr. 25[1]	5	June 13	74	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	13
Mar. 21	157	May 2	15	June 17	44	July 29	8
Mar. 23	88	May 4[4]	4	June 20	14	Aug. 1	2
Mar. 25	465	May 6	12	June 22	18	Aug. 3	7
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	20
Apr. 1[1]	117	May 13	45	June 29	13	Aug. 10	8
Apr. 4	456	May 18	30	July 1	21	Aug. 15	22
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	13
Apr. 11[2]	89	May 25	74	July 8	7	Aug. 22	22
Apr. 13	110	May 30	199	July 11	28		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Total	[illegible]
Apr. 18	117	June 6	226	July 15	16		
Apr. 20[1]	25	June 8	173	July 18	12		
Apr. 22[1]	18	June 10	110	July 22	16		

CURCULIOS CAUGHT IN EACH ROW

Row No.	Number of curculios	Percentage of total	Row No.	Number of curculios	Percentage of total
1	[illegible]	[illegible]	5	[illegible]	[illegible]
2	[illegible]	[illegible]	6	[illegible]	[illegible]
3	[illegible]	[illegible]	7	[illegible]	[illegible]
4	[illegible]	[illegible]	8	[illegible]	[illegible]

[1] [illegible]
[2] [illegible]
[3] Damp and cloudy.
[4] Damp.
[5] [illegible]

The peak of appearance from hibernation probably occurred on March 20. The peak of emergence of first-generation adults was about June 4, although first-generation adults were probably emerging before that date, since there was an abrupt increase in the number of beetles captured around May 25. The emergence of first-generation adults was early in 1922. There was a second generation and a few individuals of a third generation in the insectary that year.

A total of 3,728 beetles were captured from the eight rows in this orchard by jarring throughout the season of 1922. The percentage captured in the first three rows was much higher than in the other rows, showing that many adult curculios hibernated in the woods along the side of row 1.

In order to determine the extent of the infestation in other commercial peach orchards in the Fort Valley district early in the 1922 season, jarrings were made in several orchards that were not being used for experimental purposes. On April 5 50 trees [illegible] were jarred in the McArthur & Brother commercial orchard. These trees were in four rows and the number of curculios collected was as follows: Row 1, 83; row 2, 138; row 3, 74; row 4, 76; total, 371. In an orchard on an adjoining plantation 100 trees in five rows were jarred the same morning to determine the comparative infestation. The number of curculios captured in this orchard was as follows: Row 1, 64; row 2, 20; row 3, 34; row 4, 30; row 5, 55; total, 203.

Some commercial jarring was done by growers in 1922. On April 4 Walter Pearson, of Fort Valley, jarred one-half day with one set of frames and captured 1,000 curculios. John Pearson jarred two and one-half days with three sets of frames and captured [illegible] curculios. On April 4 the writer captured 456 beetles in the experimental orchard. The larger number collected in the Pearson orchards was probably due to the accumulation of beetles in the orchards for some time. In the experimental orchards jarrings had been made every other day previous to April 4, the date that the Pearson orchards were jarred.

These jarrings all indicate a much lighter curculio infestation in 1922 than in 1921.

Copulation and feeding take place early in the season. A pair was observed in coitu in the orchard on March 16. By April 1 the adults from hibernation had done considerable feeding on the calyxes of the peach flower.

On the morning of July 3 some special observations were made on a pair of adult beetles in coitu. The observations began at 8.22 a. m. For 35 minutes the male tapped before response. They were placed [illegible] in coitu at 9.20 a. m. At 2.30 p. m. an examination revealed them in the same position as at 9.20 a. m. There was a little feeding on a peach during the day, indicating that the female had fed during the period of coitus, or that they had separated and fed between observations. They had separated by the morning of July 4.

JARRING RECORDS OF 1923

In connection with the jarring records taken in 1923, notes were made on the appearance and abundance of the beetles in the orchard with reference to blooming, ripening of the fruit, weather, and spraying. The same block of 107 bearing Hiley trees was used for the jarrings.

ring throughout the season of 1923 as was used during the previous year (Fig. 2). Table 38 gives a summary of the results of the jarring in this orchard every third day from March 5 to August 23.

TABLE 38.—Summary of plum curculios collected by jarring the trees in eight rows in a Hiley peach orchard, Fort Valley, Ga., 1923

Date of jarring	Number of curculios	Remarks	Date of jarring	Number of curculios	Remarks
Mar. 5	1	No blossoms yet.	May 24	13	
Mar. 8	[illegible]	No blossoms yet. Cool.	June 2	[illegible]	Orchard sprayed fourth time on June 1 and 2.
Mar. 12	3	One tree in first row shows blossoms. Windy.	June 5	0	Rows [illegible] and 8 not jarred. Frames broke.
Mar. 15	2	One tree in first row shows blossoms. Cool and windy.	June 8	40	First-generation adults being collected.
Mar. 19	......	No jarring done, as it was raining and cold.	June 11	40	
Mar. 22	9	Trees show 90 per cent of bloom. Cool, heavy fog and dew.	June 14	83	
Mar. 27	[illegible]	Trees [illegible] full bloom. Warm.	June 18	41	
Mar. 30	......	No jarring done, as it was raining and cold.	[illegible]	[illegible]	
Apr. 2	37	Cold and windy. Temperature low for two days before.	June 25	[illegible]	[illegible]
Apr. 5	[illegible]	Windy. [illegible] on Apr. 3.	July 2	28	
Apr. 9	[illegible]	Cool.	July 5	28	
Apr. 12	129	80 per cent of petals off.	[illegible]	[illegible]	[illegible]
Apr. 17	74		July 12	[illegible]	
Apr. 19	13	Cool.	July 16	[illegible]	
Apr. 23	81	Warm. Orchard sprayed second time on Apr. 21.	July 19	16	Cool.
Apr. 26	68		July 23	22	
Apr. 30	37		July 26	8	
May 3	......	Raining. Could not jar.	July 30	10	
May 7	30		Aug. 2	3	
May 10	1	Orchard sprayed third time on May 9.	Aug. 6	5	
May 14	18		Aug. 9	4	
May 17	10		Aug. 13	0	
May 21	4	Jarred just after heavy rain.	Aug. 16	1	
			Aug. 20	[illegible]	[illegible]
			Aug. 23	1	
			Total	1,315	

CURCULIOS CAPTURED IN EACH ROW

Row No.	Number of curculios	Percentage of total	Row No.	Number of curculios	Percentage of total
1	[illegible]	[illegible]	6	[illegible]	[illegible]
2	226	[illegible]	7	[illegible]	[illegible]
3	[illegible]	[illegible]	8	[illegible]	[illegible]
4	[illegible]	[illegible]	Total	1,315	100
5	[illegible]	[illegible]			

The first curculio captured in the orchard in 1923 was taken on March 5. There was practically no appearance from hibernation until the trees started to bloom, and the peak of appearance occurred on March 27, when the trees were in full bloom. Only one beetle was captured on May 10, the day after this orchard was sprayed for the third time. First-generation adults probably started to emerge around June 8, and the peak of emergence was probably around June 14. There was no second generation that year. A total of 1,315 beetles were captured from this block of trees during the season of 1923, as compared with 5,728 from the same trees in 1922. This shows a great reduction in the infestation since 1922, and a tremendous reduction since 1921. The curculio-suppression campaign, waged since 1921, was largely responsible for this marked reduction in the curculio infestation. The percentage captured on the first row, the one nearest the woods, was again higher than the percentage captured on the other rows. Of the beetles captured during the season, 40.7 per cent were taken from the first row and 17.2 per cent from the second row. The percentage of beetles captured on the other six rows varied from 6.8 to 13.6.

On March 14 five pairs were noticed in coitus 24 hours after they had appeared from hibernation boxes in the insectary, again indicating that copulation takes place soon after the beetles appear from hibernation. Feeding also takes place soon after appearance from hibernation. On March 16 peach blossoms were placed in the jars containing adult beetles that had just appeared from hibernation; by the next day considerable feeding on the calyces had taken place.

The length of the period of copulation was recorded for four pairs on March 17, 1923, as follows: Pair No. 1, 10 minutes; pair No. 2, 33 minutes; pair No. 3, 1 hour; pair No. 4, 1 hour and 10 minutes. On March 23 some records were made as to how soon copulation takes place after appearance from hibernation. The time between appearance from hibernation and copulation for five pairs was as follows: Pair No. 1, 30 minutes; pair No. 2, 3 hours; pair No. 3, 6 hours; pair No. 4, 6 hours; pair No. 5, 5 minutes. On March 23 one pair was observed in copulation under the binocular for 1 hour and 20 minutes.

Adult beetles first appeared from hibernation in large numbers in 1923 on March 27, when there was a material increase in the number of beetles captured by jarring. Most of these beetles were taken from the rows near hibernating places, showing that they had just left hibernation. Low temperatures and abnormal weather conditions were perhaps responsible for holding the beetles in hibernation until late. The peach trees were practically in full bloom on March 27, and this condition of the trees brings out the beetles in numbers from hibernation.

JARRING RECORDS OF 1924

The block of bearing Hiley trees that was used for jarring records in 1922 and 1923 (fig. 2) was also used for jarring throughout the season of 1924. One more row of seven trees was added in 1924 to replace those that had died during the previous year. Notes were again made as to the correlation of the condition of the trees and the appearance of curculios in the orchard. The jarrings were made only about once each week in 1924, and on that account the record of the peaks of appearance from hibernation and of the emergence from the soil of adult curculios may not be so accurate as that of other years. Table 37 gives the weekly jarring record for this orchard from March 18 to September 16.

TABLE [illegible].—Number of plum curculios collected by jarring the trees in nine rows in a Hiley peach orchard, Fort Valley, Ga., 1924

Date of jarring	Number of curculios	Remarks
Mar. 18	[illegible]	[illegible] Trees in [illegible] about 25 per cent full bloom.
Mar. [illegible]	0	Cool and windy. Trees 75 per cent full bloom. Minimum during preceding week was 19° F.
Mar. [illegible]	[illegible]	[illegible] Beetles appearing [illegible].
Apr. [illegible]	[illegible]	Last night cool, minimum 13° F. Petals beginning to shed.
Apr. [illegible]	[illegible]	Warm. Blooms 75 per cent off. Some calyces [illegible].
Apr. [illegible]	[illegible]	Calyces about 40 per cent off. Trees [illegible] on the [illegible].
Apr. [illegible]	111	[illegible] taken [illegible].
Apr. [illegible]	[illegible]	Raining since April 2[illegible]. Cloudy and windy. [illegible]
May [illegible]	[illegible]	Warm. [illegible]
May 1[illegible]	[illegible]	[illegible]
May [illegible]	[illegible]	[illegible]
May [illegible]	[illegible]	[illegible]
June [illegible]	[illegible]	[illegible]
June [illegible]	[illegible]	Hot. Many extremely [illegible].
June [illegible]	[illegible]	
June [illegible]	[illegible]	
July 1	[illegible]	Captured one Conotrachelus anaglypticus.
July [illegible]	[illegible]	Peaches beginning to ripen.
July 1[illegible]	[illegible]	50 per cent of [illegible].
July [illegible]	[illegible]	Fruit all harvested. [illegible]
July [illegible]	[illegible]	[illegible]
Aug. [illegible]	[illegible]	[illegible]
Aug. 1[illegible]	[illegible]	[illegible] Frames broken.
Aug. [illegible]	[illegible]	Clear and hot.
Aug. 2[illegible]	[illegible]	[illegible] Conotrachelus anaglypticus.
Sept. 1	[illegible]	[illegible]
Sept. [illegible]	[illegible]	[illegible]
Sept. 1[illegible]	2	[illegible] Frames broken.
Total	1,346	

CURCULIOS CAUGHT IN EACH ROW

Row No.	Number of curculios	Percentage of total	Row No.	Number of curculios	Percentage of total
1	324	24.1	7	[illegible]	[illegible]
2	[illegible]	[illegible]	8	[illegible]	[illegible]
3	163	12.1	9	[illegible]	[illegible]
4	126	9.4	Total	1,346	[illegible]
5	108	8			
6	[illegible]	[illegible]			

The first beetles to appear in this orchard in 1924 were taken on March 29. The first beetle to appear during 1924, however, was noted on March 18, when an individual left Bermuda grass in a cage on the laboratory grounds. The cold and damp weather kept the beetles from appearing in the orchards during early March in 1924. Two to three inches of snow fell in the Georgia peach belt on the night of March 13. A peach grower reported having seen several adult curculios on Hiley blooms on March 11. There were only a few blooms out on that date. A minimum temperature of 25.5° F. was recorded on the morning of March 14, and this perhaps killed some of the beetles that had appeared from hibernation. It was so cold and rainy during the first two weeks of March that the jarring operations were not started until March 18. The first week in March was very rainy, and during the second week unusually low temperatures occurred as follows: March 11, 22.5°; March 12, 24°; March 13, 22°; March 14, 32°; March 15, 29°. Only about 30 per cent of the Hiley peaches were in full bloom by March 15. In all probability very few beetles were present in the orchards in 1924 until the third and fourth weeks in March.

Hileys were in full bloom on March 20. On this date a peach petal was found in the field showing curculio-feeding marks. Beetles were feeding vigorously in captivity on that date. One record showed that an individual started to feed on peach calyxes in 2 hours and 40 minutes after appearing from hibernation.

A stray male curculio was found near the insectary on March 19. Beetles were appearing from hibernation cages in limited numbers at the laboratory between March 18 and 25. The first copulation record was made on March 28 on a pair that emerged from hibernation cages sometime between March 18 and 25.

Fifty-one beetles were recorded from jarring on March 29. On account of a high wind that prevailed at the time of jarring, perhaps many beetles were lost during the operation. Beetles were appearing in numbers by April 3. On this date there were a few very small peaches in the orchard. "Shucks" were rapidly falling from the Hileys, and Uneedas were in full bloom. By April 8, 10 per cent of the shucks had shed from Elbertas and 25 per cent from Hileys.

The peak of appearance from hibernation in the orchard used for jarring in 1924 probably occurred about the middle of April. The peak of emergence of first-generation adults from the soil probably occurred during the latter part of June. The beetles probably started to emerge about June 10. The peak of emergence of second-generation adults from the soil probably took place about September 1. A total of 1,340 beetles were captured from the 107 trees during the 1924 season, which is only 31 beetles more than were captured during the previous season. The general curculio infestation was light in Georgia in both 1923 and 1924. The percentage captured on the first row, the one nearest the woods, was again higher than the percentage captured on other rows. Of the beetles captured during the season, 24.1 per cent were taken from the first row and 19.2 per cent from the second row. The percentage of beetles captured on the other rows varied from 3.7 to 12.1.

Table 58 brings together the monthly totals and percentages of curculios jarred from peach trees at Fort Valley, Ga., during the four years.

TABLE 58.—*Monthly total and percentage of plum curculios jarred from peach trees, Fort Valley, Ga., 1921–1924*

1921	Number of beetles	Percentage of total	1923	Number of beetles	Percentage of total
March	5,419	31.9	March	2,[illegible]	[illegible]
April	558	3.3	April	1,[illegible]	29.0
May	525	3.1	May	[illegible]	6.1
June	2,[illegible]	24.8	June	1,280	21.6
July	1,[illegible]	12.7	July	173	3.1
August	166	1.6	August	121	2.1
September	47	.5			
October	8	.1			
Total	[illegible]	100	Total	5,726	100

TABLE 58.—*Monthly catch and percentage of plum curculios jarred from peach trees, Fort Valley, Ga., 1921–1924*—Continued

1923	Number of beetles	Percentage of total	1924	Number of beetles	Percentage of total
March	157	11.9	March	51	3.8
April	588	44.7	April	411	30.5
May	78	5.9	May	135	10.0
June	297	22.6	June	250	18.6
July	180	13.7	July	347	25.8
August	16	1.2	August	21	1.6
			September	131	9.7
Total	1,315	100	Total	1,346	100

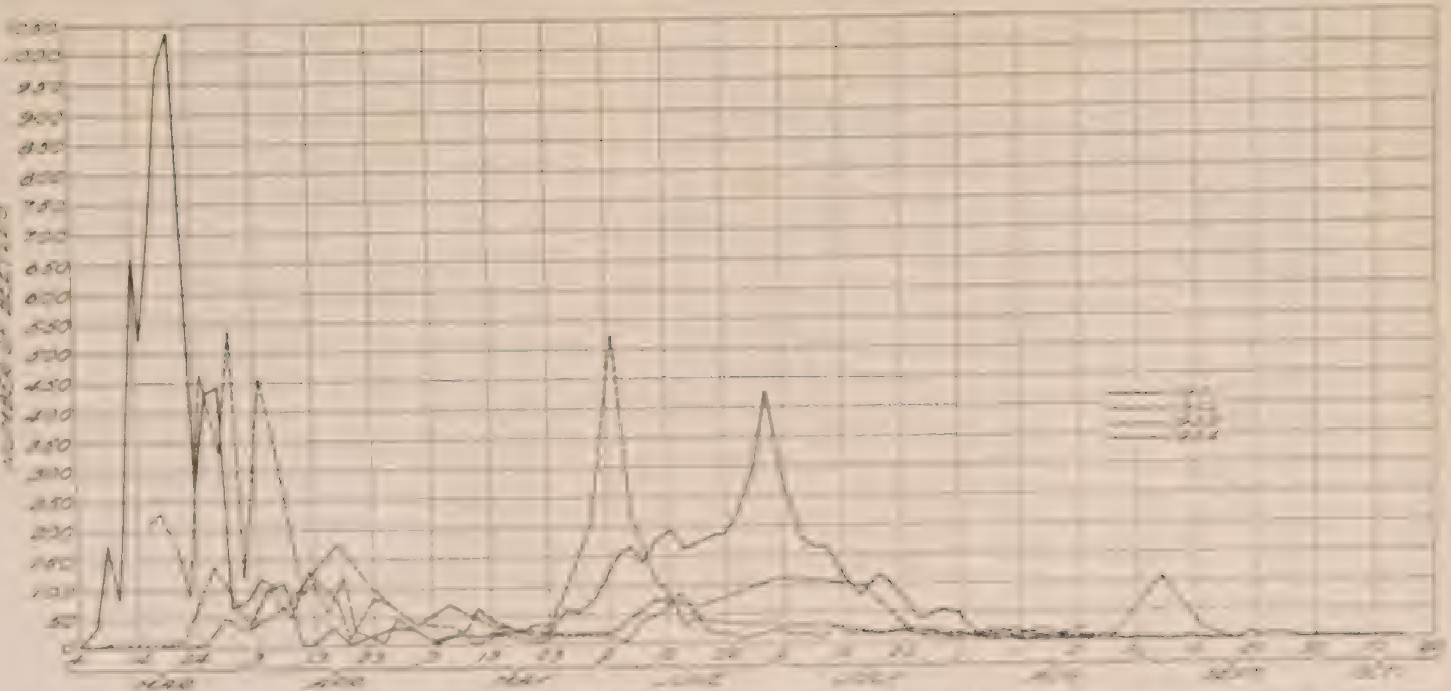
Table 58 shows that during March the percentages of curculios captured by jarring were 51.9 and 55.1 for 1921 and 1922, respectively. The beetles came out of hibernation in numbers early during 1921 and 1922, and there were two full generations in the orchards these years. The emergence of first-generation adults was heavy in June of these years. The beetles were late leaving hibernation in numbers during 1923. Only 12 per cent of the beetles were captured by jarring during March, whereas 44.7 per cent were captured during April. The peach season was not delayed in 1923 and the crop was off before many first-generation adults emerged. These were emerging during June and July. The beetles were late leaving hibernation during 1924, but as the peach season was also late that year, two generations of the insect were produced. The beetles did not appear from hibernation in numbers until April. First-generation adults were emerging during June and July, and second-generation adults were emerging during September. The numbers of adults captured by jarring during each of the four years indicate the effectiveness of the curculio-suppression campaign that was waged during those years.

Figure 8 gives a graphic comparison of the emergence of plum curculios in a commercial peach orchard as shown by jarring at Fort Valley, Ga., during the four years.

There were distinct peaks of appearance from hibernation and of emergence of first-generation adults for each of the four years. There was a distinct peak of emergence of second-generation adults for 1924. The jarring was stopped too early in 1922 to show the peak of emergence of second-generation adults. A slight rise in the number captured on September 20, 1921, may indicate a peak of emergence of second-generation adults for that year.

RELATION OF TEMPERATURE TO APPEARANCE OF PLUM CURCULIOS FROM HIBERNATION

Table 59 gives the jarring records for the four years and shows the relation between temperature and the appearance of the plum curculios from hibernation.


NUMBER OF BEETLES
1050
1000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT

[illegible]

TABLE 29.—*Jarring records showing relation of temperature to appearance of plum curculios from hibernation, Fort Valley, Ga., 1921-1924*

Date of jarring	Average mean temperature for 24 hours previous to jarring[1]	Beetles caught	Date of jarring	Average mean temperature for 24 hours previous to jarring[1]	Beetles caught	Date of jarring	Average mean temperature for 24 hours previous to jarring[1]	Beetles caught	Date of jarring	Average mean temperature for 24 hours previous to jarring[1]	Beetles caught
1921	°F.	Number	1922	°F.	Number	1923	°F.	Number	1924	°F.	Number
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Mar. [illegible]	[illegible]	1	Mar. 16	55.[illegible]	[illegible]
Mar. 7	64.74	26	Mar. 19	61.58	227	Mar. 8	48.9	1	Mar. 26	56.[illegible]	[illegible]
Mar. 9	71.00	174	Mar. 21	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Apr. [illegible]	[illegible]	[illegible]
Mar. 15	65.88	524	Mar. 28	69.46	331	Mar. 27	62.9	128	Apr. [illegible]	[illegible]	[illegible]
Mar. 17	68.75	712	Mar. 30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Mar. 21	71.92	1040	Apr. 4	67.71	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	Apr. [illegible]	[illegible]	[illegible]	Apr. 14	65.6	129	May [illegible]	[illegible]	[illegible]
Mar. 26	68.96	432	Apr. 8	69.71	282	Apr. 17	64.[illegible]	74	May [illegible]	[illegible]	[illegible]
Mar. 28	74.25	442	Apr. 11	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	May [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Apr. 21	64.50	13	May 6	68.42	12	June 2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Apr. 23	75.54	30	May 8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	30	June 21	70.[illegible]	34	Sept. 16	67.2	[illegible]
May 11	74.42	15	May 28	77.17	74	June 29	72.[illegible]	31			
May 14	68.39	21	May 30	65.24	199	July 2	75.3	28			

[1] Average mean temperature determined from hygrothermograph records.

These data substantiate the conclusion of Quaintance and Jenne[9] that a mean temperature of from 55° to 60° F. is required to cause the beetles in hibernation to become active. The beetles apparently come out of hibernation in numbers when the mean temperature has been above 60° for several successive days. In several cases beetles were jarred in numbers on days following 24-hour periods when the mean temperature was below 55°, but these beetles were probably brought out of hibernation by earlier periods of warm weather and remained on the trees. The number caught by jarring is usually greatly reduced by periods of cold weather. There are other conditions which probably influence the appearance of beetles from hibernation and the numbers caught by jarring. The odor from the blooming peach trees, and perhaps rain and wind, influence the appearance of the beetles from hibernation to some extent. Undoubtedly wind, rain, location of hibernating quarters, and the number of beetles captured by previous jarrings affect the number of beetles caught in the orchard by jarring on a given date.

---

[9] QUAINTANCE, A. L., and JENNE, E. L. Op. cit.

THE RELATION OF MOISTURE AND TEMPERATURE TO THE DEVELOPMENT OF THE CURCULIO

Moisture, as well as temperature, greatly influences the development of the curculio. Continuous rains will cause the curculio in the several stages to remain in the soil longer than normally, and this is undoubtedly responsible for only one brood in some years, on account of delay in the emergence of first-generation adults until after the peaches are harvested. The development of the adult during the pupal stage is prolonged by a drought. Very dry soil, especially if there is a crust on the surface, will delay the escape of newly emerged adults from the soil. Some of the tender, newly transformed adults may be killed while trying to escape from dry and hard soil. A drought during the pupation period would therefore tend to delay the emergence of new adults from the soil.

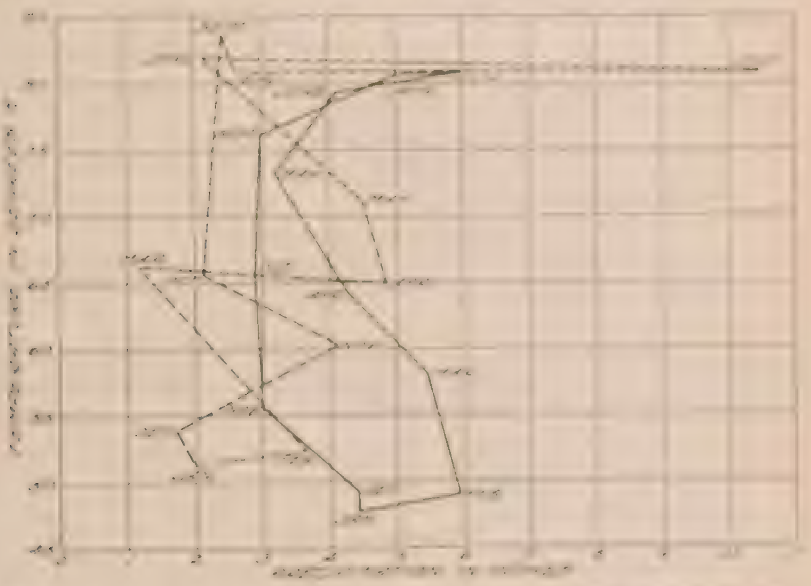


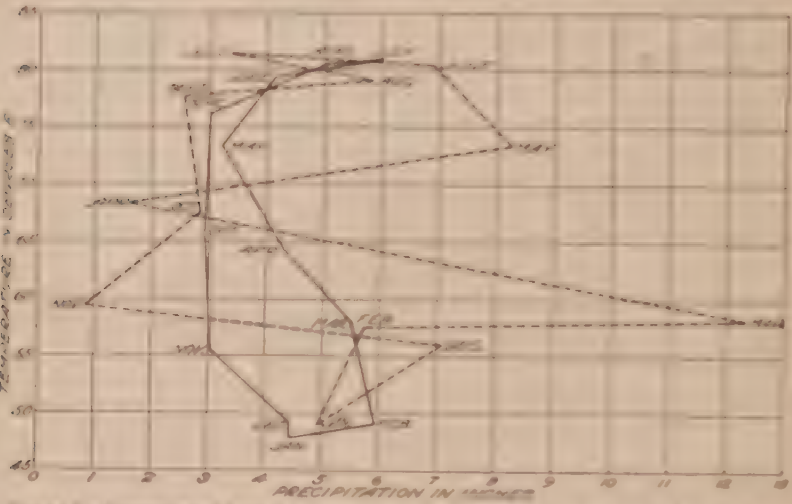
FIGURE 4.—Comparison of normal monthly precipitation and temperature at Marshallville, Ga., for 20 years, with precipitation and mean temperature by months for the year 1921. Points indicating normal data are connected by a solid line; those indicating data for 1921 by a broken line

See XV 581

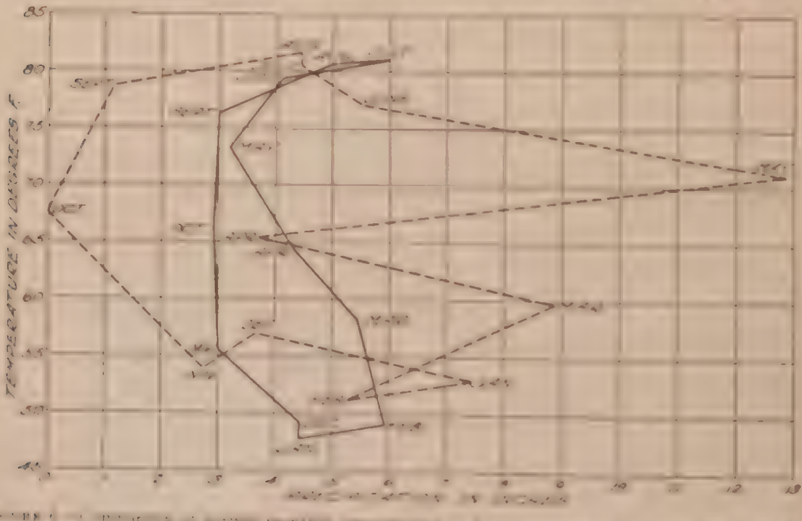
Low temperatures and cold spring rains will retard the appearance of overwintered adults from hibernation in the spring. This will cause the deposition of first-generation eggs later than normal and consequently the emergence of first-generation adults later than usual. This condition would influence the number of broods, in that the first-generation beetles might not emerge from the soil until after peach harvest, leaving no host for the deposition of second-generation eggs.

The four climographs in Figures 4, 5, 6, and 7, showing the rainfall and temperature for 1921, 1922, 1923, and 1924, as compared with a 20-year average at Marshallville, Ga., 7 miles from Fort Valley, are given to show the influence of these climatic factors on the development of the curculio during the four years that the life-history studies were under way.

From the 1921 climograph it will be noted that the temperature was considerably higher than normal during March and the rainfall was much below normal. The temperature was also higher and the rainfall less than normal during February. These conditions caused the adult curculios to leave hibernation early. They appeared in the orchards in numbers during the early part of March and the peak of appearance was reached that year by March 21. Weather conditions were normal during the period when the insect was in the soil passing through the stages of development, and the first-generation



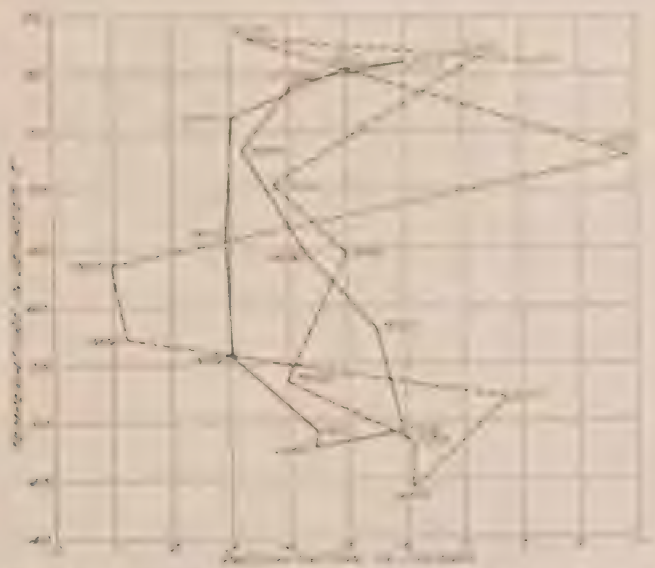
[illegible]



[illegible]

adults were emerging in numbers before any of the late varieties of peaches were harvested. Second-generation eggs were deposited in the fruit on the trees and a complete second generation of the curculio occurred that year. The rainfall during July was much above normal, but this had very little influence on the number of broods that year, as it occurred after the emergence of the first-generation adults. It may have caused the earliest larvae of the second generation to remain as larvae in the soil for a longer time than normal and thereby delayed the emergence of second-generation adults from the soil. Second-generation adults were emerging from August 13 to September 4. There was no oviposition by these adults in 1921.

In 1922 the beetles again appeared early from hibernation. They started to appear in the orchards on March 1 and could be collected in numbers during March. The peak of appearance from hibernation was reached on March 30. As shown by the 1922 climograph, the mean temperature for February was 6° above normal. This is perhaps responsible for the early appearance of the beetles from hibernation, even though the rainfall in March was much above normal. The mean temperature for March, however, was normal. First-generation adults started to emerge from the soil on May 20. They emerged in numbers before any of the late varieties of peaches were harvested and deposited second-generation eggs in them. There was a complete second generation in 1922, and one adult of a third generation was reared in the insectary. Second-generation adults therefore mated, and some third-generation eggs were deposited in 1922, the only year in the four when this occurred. Second-generation adults started to emerge on July 27, the earliest date of second-generation emergence during the four years, and continued to emerge until October 24. While the May precipitation was above normal, the temperature was



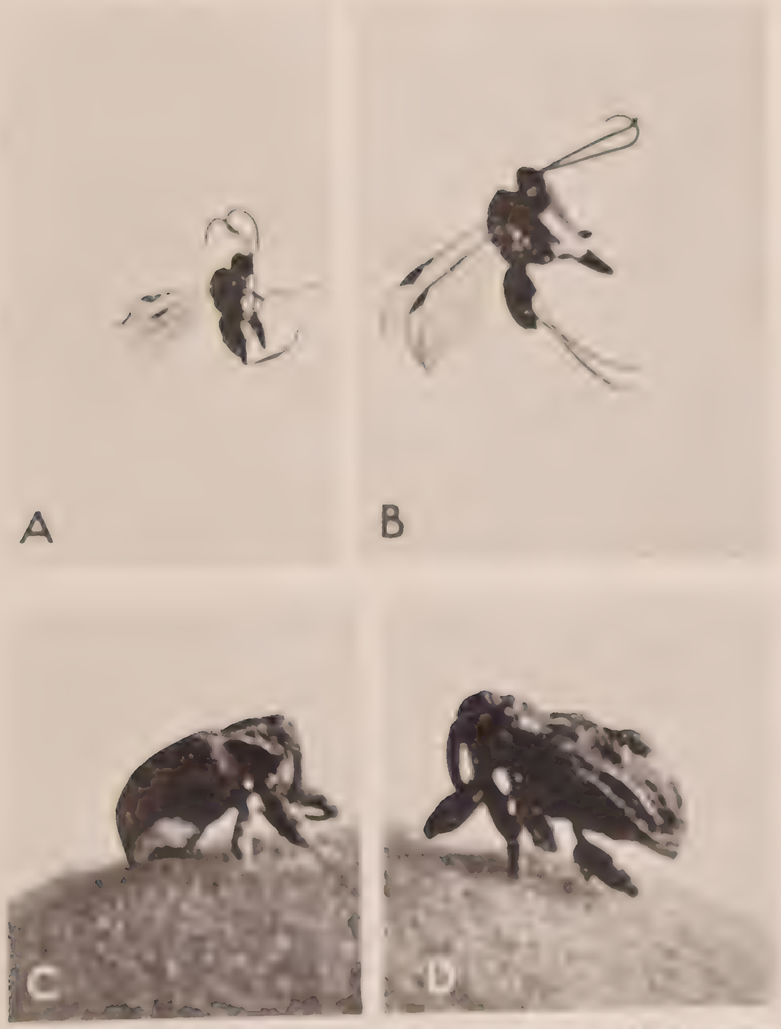
[illegible]

normal, and as there was a precipitation deficiency with above-normal temperature in April when most of the first-generation larvae were in the soil passing through the stages of transformation, the emergence of first-generation adults was not delayed, and they were appearing in numbers before the late peaches were off the trees. The temperature and rainfall during July, August, September, and October were about normal, and the second generation developed under optimum conditions, the adults emerging over a long period from July 27 to October 24.

The beetles were late leaving hibernation in 1923. Even though the jarring record shows that one curculio appeared in the orchard on March 5, the beetles did not start to leave hibernation in numbers until March 22. The peak of appearance from hibernation was reached on March 27. The climograph for 1923 shows that the early spring was wet and cool. The mean temperature for both January and February was above normal, and while the March mean temperature was a little above normal there was an excess of rainfall. These weather conditions kept the beetles in hibernation later than normal. First-generation adults did not start to emerge from the soil until June 7. They continued to emerge until September 26. Some of the first-generation eggs were therefore deposited very late. The rainfall during May was more than 2 inches above normal, and the temperature was a little under normal. There was also an excess of rainfall and a mean temperature below normal in June. These conditions were very unfavorable for the development of the curculio in the soil. The peach crop was harvested in Georgia before the majority of the first-generation adults were fertilized and ready to deposit eggs. Consequently only one generation of the curculio occurred in Georgia peach orchards in 1923. This was the only year during the course of these life-history investigations that two generations did not occur.

The beetles were again late in leaving hibernation in 1924. They did not start leaving in numbers until March 29, although the first beetle was noted on March 18. The peak of appearance from hibernation did not occur until about the middle of April. As shown by the 1924 climograph, the spring was very cold. The mean temperature for March, when most of the beetles are usually appearing from hibernation, was much below normal. January and February temperatures were also below normal. Rains were frequent in March, and 2 to 3 inches of snow fell on March 15. These conditions prevented the beetles from appearing from hibernation at the normal time and also were responsible for a late blooming season. Weather conditions were normal during April, May, and June, except that the June precipitation was a little above normal. As a result, the first generation developed in normal time in the soil, and first-generation adults started to emerge on June 8. They were emerging in numbers by the middle of the month. As the peach season was late, first-generation adults were emerging in numbers before the crop was harvested. Second-generation eggs were deposited under fairly normal conditions, and a second generation of adults occurred. They started to emerge on August 21 and continued to emerge until October 11.

Even though the hibernated adults were as late appearing in the orchards in 1924 as in 1923, two generations of the insect occurred in Georgia in 1924, whereas only one generation occurred in 1923. The 1923 peach season was about two weeks earlier than the 1924 season, and as unfavorable conditions occurred during the pupation season of the first generation in 1923, the adults did not emerge in time to


A
B
C
D

[illegible]

deposit second-generation eggs before the fruit was harvested. Normal conditions occurred during the 1924 pupation, and first-generation adults emerged well in advance of the harvest of the late varieties of peaches. Second-generation eggs were deposited in the fruit, and a second generation of adults was produced. The number of beetles appearing from hibernation and in the orchard throughout the 1924 season was, however, just a very few more than in 1921. The control measures enforced in 1924 were very effective in preventing an increase from the two generations.

PARASITES OF THE PLUM CURCULIO IN GEORGIA

The most important and most common parasite of the plum curculio in Georgia is the hymenopterous parasite of the larva (Braconidae) *Triaspis curculionis* Fitch. (Pl. 10, A, B.) This insect was reared in large numbers during each of the four years that the curculio studies were under way. (8.) *T. curculionis* var. *rufus* Riley was also reared in numbers each year. Two important dipterous parasites of the curculio larva that were reared at Fort Valley are *Myiophasia globosa* Townsend and *Cholomyia longipes* Fab. The only egg parasite which was reared was the hymenopterous parasite (*Anaphes*) *Anaphoidea conotracheli* Girault.

During the season of 1921 a record was kept of the emergence of *Triaspis curculionis* from 15 parasite boxes in which 11,116 curculio larvae were placed from April 10 to 28. Table 60 shows that 0.7 per cent of these curculio larvae were parasitized by *T. curculionis*. This percentage is unusually low and may be due to the number of larvae unaccounted for, many of which were probably destroyed by ants. Only 901 of the 11,116 larvae, or 8.9 per cent, transformed to adults and were recorded as such as they emerged from the soil. The first *T. curculionis* issued on May 2, and the last was recorded on June 9. The heaviest emergence was between May 13 and 21. Of the *T. curculionis* issuing from the curculio larvae that reached maturity between April 10 and 28, 28.4 per cent were males and 71.6 per cent were females.

TABLE 60.—*Emergence of Triaspis curculionis from plum-curculio larvae during season of 1921 at Fort Valley, Ga.*

Cage No.	Date larvae were placed in soil	Larvae placed in soil	Triaspis curculionis emerging ¹		Larvae parasitized by Triaspis curculionis	Beetles emerging	Larvae transforming to adults
			Male	Female			
		Number	*Number*	*Number*	*Per cent*	*Number*	*Per cent*
	Apr. 10	990	7	20	2.6	205	20.9
	Apr. 11	1,260	5	9	1.1	120	9.5
	Apr. 12	899	5	10	1.7	77	8.6
	Apr. 13	1,332	1	7	.6	135	10.1
	Apr. 14	1,342	0	2	.1	200	14.9
	Apr. 15	1,101	0	0	.0	39	3.5
	Apr. 16	1,156	0	0	.0	27	2.3
	Apr. 17	1,245	0	2	.2	69	5.5
	Apr. 18	775	3	3	.8	79	10.2
	Apr. 19	375	0	0	.0	10	2.7
	Apr. 20	214	0	0	.0	13	6.1
	Apr. 21	249	0	0	.0	1	.4
	Apr. 22	155	0	0	.0	2	1.3
	Apr. 25	94	0	0	.0	3	3.2
	Apr. 28	69	0	0	.0	1	1.4
Total or average	....	11,116	21	53	.7	901	8.9

[1] *Triaspis curculionis* emerged from [illegible]; males, 28.4 per cent; females, 71.6 per cent.

TABLE 61.—*Emergence of Triaspis curculionis from plum-curculio larvae during season of 1922 at Fort Valley, Ga.*

Cage No.	Date larvae were placed in soil	Larvae placed in soil	Triaspis curculionis emerging ¹		Larvae parasitized by Triaspis curculionis	Beetles emerging	Larvae transforming to beetles
			Male	Female			
		Number	Number	Number	Per cent	Number	Per cent
1	Apr. 24	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	Apr. 25	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	Apr. 27	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	Apr. 28	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	Apr. 29	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	Apr. 30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7	May 1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8	May 2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total or average		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

¹ [illegible]

In 1922 a record was kept of the emergence of *T. curculionis* from eight parasite boxes in which 2,552 curculio larvae were placed from April 24 to May 2, and of these 0.7 per cent were parasitized by *T. curculionis*. This is the same degree of parasitism as recorded in 1921. Of the 2,552 larvae, 47.7 per cent transformed to adult curculios. The first *T. curculionis* issued on May 17 and the last on June 15. The heaviest emergence was during the latter part of May. Of the *T. curculionis* issuing from the curculio larvae that reached maturity between April 24 and May 2, 1922, 54.5 per cent were males and 45.5 per cent females.

Table 62 gives a record of *T. curculionis* issuing from curculio larvae that were placed in individual vials from May 8 to 12. These parasites, all females, issued from June 5 to 17.

TABLE 62.—*Emergence of Triaspis curculionis from plum-curculio larvae placed in individual vials during season of 1922, Fort Valley, Ga.*

Date larvae were placed in vials	Larvae placed in vials	Triaspis curculionis emerging ¹	Larvae parasitized by Triaspis curculionis	Beetles emerging	Larvae transforming to beetles
	Number	Number	Per cent	Number	Per cent
May 8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
May 10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
May 11	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
May 12	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total or average	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

¹ *Triaspis curculionis* emerged from June 5 to 17; all females.

TABLE 63.—*Emergence of Triaspis curculionis and other parasites from plum-curculio larvae during season of 1923 at Fort Valley, Ga.*

Cage No.	Date larvae were placed in soil	Larvae placed in soil	Parasites emerging						Larvae parasitized by—
			Triaspis curculionis[1]		*Triaspis curculionis* var. *rufus*[2]		*Myiophasia globosa*	*Cholomyia longipes*	*Triaspis curculionis*
			Male	Female	Male	Female			
		Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Per cent*
1	May 2	[illegible]	0	0	0	0	1	0	
2	May 4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	May 5	[illegible]	33	66	1	1	0	0	14.3
4	do	[illegible]	9	2	0	1	3	0	1.6
5	do	[illegible]	11	6	0	1	0	0	2.6
6	May 6	[illegible]	20	27	0	1	0	0	6.2
7	do	[illegible]	14	13	0	1	0	0	4.3
8	May 7	[illegible]	4	6	0	1	1	0	1.3
9	May 8	[illegible]	16	22	0	1	0	0	[illegible]
10	do	[illegible]	41	31	1	1	0	0	[illegible]
11	May 9	[illegible]	15	27	[illegible]	3	1	0	[illegible]
12	May 17	[illegible]	9	15	1	1	1	0	6.2
13	Aug. 2	[illegible]	0	0	0	0	0	1	..
Total or average		6,703	176	205	3	11	6	1	[illegible]

Cage No.	Date larvae were placed in soil	Larvae placed in soil	Larvae parasitized by—			Larvae parasitized by all species	Beetles issuing	Larvae issuing as beetles	Larvae not accounted for
			Triaspis curculionis and var. *rufus*	*Myiophasia globosa*	*Cholomyia longipes*				
		Number	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Number*	*Per cent*	*Per cent*
1	May 2	[illegible]	....	20.0		20.0	0	[illegible]	[illegible]
2	May 4	[illegible]	[illegible]		....	14.6	64	11.6	73.8
3	May 5	[illegible]	2	.3	....	2.4	34	5.0	[illegible]
4	do	[illegible]	.2	....	....	3.1	114	19.8	[illegible]
5	do	[illegible]	.3	....	....	8.5	119	20.2	[illegible]
6	May 6	[illegible]	.3	....	....	4.5	124	20.3	[illegible]
7	do	[illegible]	3	....	....	1.9	122	16.9	[illegible]
8	May 7	[illegible]	.2	.2	....	7.8	103	20.4	[illegible]
9	May 8	[illegible]	.2	....	....	9.9	163	21.2	68.8
10	do	[illegible]	.3	....	....	6.3	166	22.4	[illegible]
11	May 9	[illegible]	.2	.1	....	6.9	156	20.5	72.4
12	May 17	[illegible]	.3	.2	....	[illegible]	[illegible]	[illegible]	[illegible]
13	Aug. 2	[illegible]	....	....	20.00	20.0	1	20.0	60.0
Total or average		6,703	[illegible]	.1	.01	6.0	1,273	19.0	75.0

[1] [illegible]

[2] [illegible]

A record was kept of the emergence of *T. curculionis*, *T. curculionis* var. *rufus*, *Myiophasia globosa*, and *Cholomyia longipes* during the 1923 season from 13 parasite boxes, in which 6,703 curculio larvae were placed from May 2 to 17 and on August 2. Only 1,273 beetles emerged from the 6,703 larvae, leaving 75 per cent of the larvae unaccounted for, after allowing for those that were parasitized. The 6 per cent parasitism of larvae in 1923 was undoubtedly a factor that contributed to the control of the curculio that year.

The first *T. curculionis* issued in 1923 on May 24, and the last on July 16. The first *T. curculionis* var. *rufus* issued in 1923 on May 28, and the last on June 8. One specimen of *Cholomyia longipes* issued from these curculio larvae during the 1923 season.

Table 64 gives the record of emergence of *Triaspis curculionis*, *T. curculionis* var. *rufus*, and *Myiophasia globosa* during the 1924 season from 11 parasite boxes, in which 3,037 curculio larvae were placed from April 29 to May 24.

TABLE 64.—*Emergence of Triaspis curculionis and other parasites from plum-curculio larvae during season of 1924, Fort Valley, Ga.*

Cage No.	Date larvae placed in soil	Larvae placed in soil	Parasites emerging: Triaspis curculionis[1]: Male	Parasites emerging: Triaspis curculionis[1]: Female	Parasites emerging: Tersilochus conotracheli var. rufus	Parasites emerging: Myiophasia globosa	Larvae parasitized by—: Triaspis curculionis	Larvae parasitized by—: Tersilochus conotracheli var. rufus	Larvae parasitized by—: Myiophasia globosa	Larvae parasitized by all parasites	Adults emerging	[illegible]	Larvae not accounted for
		Number	*Number*	*Number*	*Number*	*Number*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*No.*	*Per cent*	*Per cent*
1	Apr. 29	6	2	0	0	0	33.3	......	......	33.3	0	......	66.7
2	Apr. 30	10	2	2	0	0	40.0	......	......	40.0	0	......	60.0
3	May 1	10	2	1	0	0	30.0	......	......	30.0	5	50.0	20.0
4	May 1, 2, 3	400	85	49	0	0	33.5	......	......	33.5	40	10.0	56.5
5	May 4, 5	453	77	52	0	1	28.5	......	0.2	28.7	58	12.8	58.5
6	May 5, 6	400	44	53	2	0	24.3	0.5	......	24.8	93	23.2	52.0
7	May 6, 7, 8	400	41	35	1	0	19.0	.3	......	19.3	111	27.7	53.0
8	May 8, 9	927	55	90	0	3	15.6	......	.3	16.0	176	19.0	65.0
9	May 9, 10, 11	526	64	67	1	0	24.9	.2	......	25.1	164	31.2	43.6
10	May 12, 13, 14	543	35	55	1	1	16.6	.2	.2	16.9	179	33.0	50.1
11	May 15 to 24	323	11	17	1	1	8.7	.3	.3	9.3	167	51.7	39.0
Total or average		3,997	418	421	6	6	20.9	.2	.2	21.3	993	24.8	53.9

[1] [illegible]

[2] [illegible]

This table shows that 20.9 per cent of the larvae were parasitized by *T. curculionis*, 0.2 per cent by *T. conotracheli* var. *rufus*, and 0.2 per cent by *M. globosa*. From the 3,997 larvae, 993 adult curculios emerged, leaving 53.9 per cent of the larvae unaccounted for after allowing for those that were parasitized. The parasitism was unusually heavy in 1924 and in all probability was a very important factor in the control of the curculio that season.

The first *T. curculionis* of 1924 issued on May 26 and the last on July 15. The first *T. conotracheli* var. *rufus* issued on June 6 and the last on June 18. The first female *T. curculionis* did not appear until two days after the appearance of the first male. The males of *T. curculionis* were the first to appear in numbers, and the females did not appear in numbers until five days after the males started to issue.

FEEDING TESTS WITH LEAD ARSENATE

A number of experiments were conducted during each of the four years to test the toxicity of different forms of lead arsenate and other materials for curculio control. The most important phase of this work consisted of the tests dealing with the comparative toxicity of the acid lead arsenate ($PbHAsO_4$) when applied as a liquid spray and as a dust. Basic lead arsenate, a reduced dosage of acid lead arsenate, the addition of calcium caseinate to the lead-arsenate spray, and nicotine sulphate were also used in these tests.

In 1921 these feeding tests were conducted by spraying or dusting a peach limb containing small peaches, and then tying over one of the twigs a paper bag in which a number of adult curculios were confined. Observations for mortality of the insects were made every day or two thereafter. Table 65 gives the results of the tests of 1921.

TABLE 63.—*Tests of the killing effect on the plum curculio of sprays and dusts on twigs in bags containing peaches and foliage, Fort Valley, Ga., [illegible]*

Test No.	Insecticide used and date beetles were confined	Number of beetles dying on—							Remarks
		Mar. 13	Mar. 14	Mar. 15	Mar. 17	Mar. 19	Mar. 21	Apr. 3	
1	20 beetles confined Mar. 12 in bag over twig containing peaches and foliage sprayed with basic lead arsenate paste at rate of 3 lbs. to 50 gals. water, with lime	0	1	0	0	2	..	10	65 per cent mortality in 22 days, when test was closed.
2	Same as test No. 1, only acid lead arsenate powder used at rate of 1 lb. to 50 gals. of spray	0	[illegible]	[illegible]	[illegible]	[illegible]	..	[illegible]	70 per cent mortality in 22 days, when test was closed.
3	Same as test No. 1, only twig dusted with 80 per cent sulphur, 5 per cent acid lead arsenate, and 15 per cent hydrated lime	1	0	2	[illegible]	2	..	13	90 per cent mortality in 22 days, when test was closed.
4	Same as test No. 3, only 80 per cent sulphur, 10 per cent acid lead arsenate, and 10 per cent hydrated lime dust used	1	0	2	1	3	..	11	Do.
5	19 beetles confined Mar. 10 in bag over twig containing peaches and foliage sprayed with acid lead arsenate powder at rate of 1 lb. to 50 gals. water, with lime	...	0	2	[illegible]	[illegible]	[illegible]	..	63 per cent mortality in 13 days, when test was closed.
6	Duplicate of test No. 5, only 18 beetles used	...	3	3	2	2	4	..	78 per cent mortality in 13 days, when test was closed.
7	19 beetles confined Mar. 10 in bag over twig containing peaches and foliage sprayed with basic lead arsenate paste at rate of 2 lbs. to 50 gals. water, with lime	...	0	1	0	0	3	.	21 per cent mortality in 13 days, when test was closed.
8	Duplicate of test No. 7, only 13 beetles used	...	0	0	0	0	1		8 per cent mortality in 13 days, when test was closed.
9	19 beetles confined Mar. 10 in bag over twig containing peaches and foliage dusted with 80 per cent sulphur, 5 per cent acid lead arsenate, and 15 per cent hydrated lime	.	0	3	11	3	0		[illegible] per cent mortality in 13 days.
10	Duplicate of test No. 9, only [illegible] beetles used	...	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible] per cent mortality in 13 days.
11	18 beetles confined Mar. 10 in bag over twig containing peaches and foliage dusted with 80 per cent sulphur, 10 per cent acid lead arsenate, and 10 per cent hydrated lime	...	0	4	6	4	4	..	100 per cent mortality in 13 days, when test was closed.
12	Duplicate of test No. 11, only 19 beetles were used.	...	0	4	8	[illegible]	3	...	[illegible] per cent mortality in 13 days.
13	[illegible] beetles confined Mar. 10 in bag over twig containing peaches and foliage that had received no treatment (check).	...	[illegible]	0	0	0	0	..	All beetles were alive and active in 13 days, when test was closed. There was about as much feeding on the treated foliage as on the check.
14	Duplicate of test No. 13	...	...	1	0	1	0	...	10 per cent mortality in 13 days. Others all alive and active when test was closed.

[1] Three sick. [2] One sick. [3] Two sick. [4] Four sick.

Basic (or triplumbic) lead arsenate, in both feeding tests and orchard spraying experiments, has been found to be slower in killing curculios than the acid or diplumbic form. It will be noted in the above tests that the diplumbic was quicker and killed more of the insects than the triplumbic. In test 1 the triplumbic as a spray killed 65 per cent of the beetles within 22 days, whereas the diplumbic as a spray killed 70 per cent and as a dust killed 90 per cent in the same time. The curculio mortality was the same in test 4, where 10 per cent acid lead arsenate was used, as in test 3, where only 5 per cent was used.

In the other series the triplumbic gave very poor results. In tests 7 and 8 this form of lead arsenate killed only 21 and 8 per cent of the beetles within 13 days. The diplumbic form applied as a spray killed 63 and 78 per cent within 13 days, as reported in tests 5 and 6. Five per cent of acid lead arsenate in a dust mixture gave a curculio mortality within 13 days of 79 and 75 per cent in tests 9 and 10. The 10 per cent used in tests 11 and 12 gave a curculio mortality within 13 days of 100 and 95 per cent.

The acid lead arsenate was not only more toxic and a quicker killer of the curculio than the basic lead arsenate, but it frequently caused severe sickness of the curculios the day following the feeding. Even though there was not much mortality of the curculios from the acid lead arsenate until several days after the application, there was sufficient sickness from it the day following to stop oviposition.

The feeding tests of 1922 were conducted in a manner similar to those of 1921. The beetles were placed in paper bags, which were tied over a sprayed or dusted peach twig containing fruit and foliage. Observations for curculio mortality were made daily. As the feeding tests and orchard spraying experiments of 1921 had shown that the basic lead arsenate was much slower in killing the beetles and was not so toxic as the diplumbic form, it was not included in the tests of 1922, the results of which are given in Table 66.

TABLE 66.—*Tests of the killing effect on the plum curculio of sprays and dusts on twigs on trees containing peaches and foliage, Fort Valley, Ga., 1922*

Test No.	Insecticide used and date beetles were confined	Number of beetles dying on— May 13	May 1[illegible]	May 1[illegible]	May 1[illegible]	May 1[illegible]	May 1[illegible]	Remarks
1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]
2	Duplicate of test No. 1	[illegible]	[illegible]	[illegible]	[illegible]			[illegible] days. No mortality until [illegible]
3	[illegible] cent lime.			[illegible]	[illegible]			[illegible]
4	Duplicate of test No. 3			[illegible]	[illegible]			Do.
5	[illegible] sulphur, 5 per cent lead arsenate, and 15 per cent lime.			[illegible]	[illegible]			Do.
6	Duplicate of test No. 5			0	4			Do.
7	6 beetles confined May 9 in bag over twig containing peaches and foliage [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8	Duplicate of test No. 7, except beetles confined May 11.			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
9	5 beetles confined May 20 in bag over twig containing peaches and foliage sprayed with lead arsenate [illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10	[illegible] peaches and foliage dusted with 80 per cent sulphur, 10 per cent lead arsenate, and 10 per cent lime.	[illegible]	[illegible]					[illegible]
11	Duplicate of test No. 10.							[illegible]
12	5 beetles confined May 20 in bag over twig containing peaches and foliage dusted with 80 per cent sulphur, 5 per cent lead arsenate, and 15 per cent lime.	3	[illegible]					Do.
13	Duplicate of test No. 12.	1	[illegible]	[illegible]				[illegible] No mortality until third day.
14	5 beetles confined May 20 in bag over twig containing [illegible]	0	0	0	0			No mortality at the end of [illegible]

In the first series of tests (1 to 8) there was no mortality until 4 days after the application of the poison, although sickness, which stopped oviposition, occurred soon after the feeding. The acid lead arsenate, applied as a spray, gave a 100 per cent mortality of the curculio in 6 days. The 5 per cent and 10 per cent acid lead arsenate applied in a dust mixture gave a 100 per cent mortality in 6 days.

In the second series of tests (9 to 14) the lead-arsenate spray gave a 100 per cent mortality in 8 days. The 5 per cent lead-arsenate dust gave a 100 per cent mortality in 4 and 5 days, and the 10 per cent lead-arsenate dust gave 100 per cent mortality in 4 days. There was no mortality until the third day after the applications of the poison.

The 1923 feeding tests were conducted on poisoned twigs in a peach orchard, and also in jars in the insectary, in which were placed poisoned peach foliage and fruit. Table 67 gives the results of the tests in 1923.

TABLE 67.—*Tests of the killing effect on the plum curculio of* [illegible] *lead-arsenate sprays and* [illegible] *peaches and foliage. Fort Valley, Ga.,* [illegible]

Test No.	[illegible]	Number of beetles dead on—															Remarks
		Apr. [illegible]	Apr. [illegible]	Apr. [illegible]	Apr. [illegible]	Apr. [illegible]	Apr. [illegible]	Apr. [illegible]	Apr. 19	Apr. [illegible]	Apr. [illegible]	Apr. [illegible]	Apr. [illegible]	Apr. [illegible]	Apr. [illegible]	Apr. [illegible]	
1	[illegible] Apr. 11 [illegible] age [illegible] l ars[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]							[illegible]
2	[illegible] 1 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]							[illegible]
3	[illegible] 11 [illegible] ge a[illegible] lb. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]							[illegible]
4	[illegible] 11 [illegible] ge [illegible] lb. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2	[illegible]							[illegible]
5	[illegible], on[illegible] of 6 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]							[illegible]
6	[illegible] 11 [illegible] ge a[illegible] tmen[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]							[illegible]
7	[illegible] 12 [illegible] per [illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8	[illegible] 12 [illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9	[illegible] 12 [illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10	[illegible]		[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]
11	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Tree No.	[illegible]	[illegible]													Remarks
		Apr. [illegible]	Apr. [illegible]	Apr. [illegible]	Apr. [illegible]	Apr. [illegible]	Apr. [illegible]	Apr. [illegible]	Apr. [illegible]	Apr. [illegible]	Apr. [illegible]	Apr. [illegible]	May [illegible]	May [illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] scale water, with lime [illegible] arsenate added to spray) [illegible] spray)	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

The 5 per cent lead arsenate used in the dust mixture on peach twigs in an orchard, as reported for tests 1 and 2, gave a mortality of only 10 per cent and 30 per cent of the curculios within 9 days. The three-fourths of a pound of lead arsenate to 50 gallons of water gave only 10 per cent mortality within 9 days in test 3, whereas the 1 pound to 50 gallons of water gave a mortality of 30 per cent in the same time. The addition of calcium caseinate to the spray, as reported for test 5, did not increase the effectiveness of the lead arsenate.

In cage tests in the insectary the dust containing 5 per cent lead arsenate with lime, and with lime and sulphur, gave a 90 per cent curculio mortality within 11 and 12 days, respectively. The three-fourths of a pound of lead arsenate to 50 gallons of water gave a 100 per cent mortality within 14 days, whereas the 1-pound strength gave the same mortality within 12 days. The addition of calcium caseinate in test 11 did not increase the effectiveness of the lead arsenate, as it took 14 days in this test to give a 100 per cent mortality.

The last series of feeding tests (13 to 17) in Table 67 are particularly interesting in that they were conducted on trees in an orchard that had been sprayed or dusted commercially by the usual power outfits. There was a mortality of 80 per cent of the curculios within 18 days in the plat that had received lead arsenate at the rate of 1 pound to 50 gallons of water, with the addition of 3 pounds of unslaked lime. There was a 100 per cent mortality within 13 days in the plat that received lead arsenate at the rate of 1 pound to 50 gallons of water, with lime, and the addition of calcium caseinate at the rate of 6 ounces to 50 gallons. There was an 80 per cent curculio mortality within 18 days in the plat that had received lead arsenate at the rate of three-fourths of a pound to 50 gallons of water, with lime. There was an 80 per cent mortality of the curculios within 18 days in the plat that was dusted with 5 per cent lead arsenate and 95 per cent hydrated lime. There was no curculio mortality within 18 days in the plat that had received no treatment. In these tests, where the trees were treated commercially, as by a grower, the 5 per cent lead-arsenate dust gave as good curculio mortality as the liquid spray where the lead arsenate was used at the rate of three-fourths or 1 pound to 50 gallons of water. The test where calcium caseinate was added to the spray gave a somewhat higher curculio mortality than where it was omitted, although other tests show that this material did not increase the effectiveness of the lead arsenate.

In practically all of the feeding tests of 1923 the curculios were sick on the day following the application of the poison. In two tests mortality started on the day following the treatment.

Reports of the use of nicotine sulphate with some degree of success against the cotton boll weevil were received during the fall of 1923. It then occurred to the writer that this insecticide should be tested against the plum curculio. Consequently, in 1924 a number of feeding tests were made with this material, the results of which are given in Table 68.

TABLE [illegible].—Tests of the killing effects on the plum curculio of [illegible]

Test No.	Date of dusting	Kind of dust used	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Remarks
				Number	Number		Per cent	
1	Mar. 29	[illegible] kaolin.	Mar. 2[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
2	do	do	1 on each day, Mar. 29 to Apr. 7, inclusive.	[illegible]	[illegible]	Mar. [illegible]	[illegible]	[illegible]
3	do	[illegible]	Mar. 29	[illegible]	[illegible]		[illegible]	[illegible]
4	do	do	1 on each day, Mar. 29 to Apr. 7, inclusive.	[illegible]	[illegible]		[illegible]	[illegible]
5	do	[illegible] in kaolin.	Mar. 29	[illegible]	[illegible]	Mar. [illegible]	[illegible]	[illegible]
6	do	do	1 on each day, Mar. 29 to Apr. 7, inclusive.	[illegible]	[illegible]	Apr. [illegible]	[illegible]	[illegible]
7	do	[illegible] and hydrated lime.	Mar. 29	[illegible]	[illegible]	Mar. [illegible], Apr. [illegible]	[illegible]	[illegible]
8	do	do	1 on each day, Mar. 29 to Apr. 7, inclusive.	[illegible]	[illegible]		[illegible]	[illegible]
	Total			[illegible]	[illegible]		[illegible]	[illegible]
9		No treatment (check)	Mar. 29	10	0		[illegible]	[illegible]
10	Apr. [illegible]	[illegible] kaolin.	Apr. [illegible]	[illegible]	[illegible]		[illegible]	[illegible]
11	Apr. 11, 13	do	do	10	3	Apr. 20, 21, 23	30	Do.
12	Apr. 11, 13, 19	do	do	10	0		0	Do.
13	Apr. 11, 13, 19, 2[illegible]	do	do	10	0		0	Do.
[illegible]	Apr. [illegible]	do	[illegible]	[illegible]	[illegible]	Apr. [illegible]	[illegible]	Do.
[illegible]	Apr. [illegible]	do	do	[illegible]	[illegible]	Apr. [illegible]	[illegible]	[illegible]
[illegible]	Apr. [illegible]	do	do	[illegible]	[illegible]	Apr. [illegible]	[illegible]	[illegible]
[illegible]	Apr. [illegible]	do	do	[illegible]	[illegible]	Apr. [illegible]	[illegible]	[illegible]
15		No treatment (check)	Apr. 11	10	0		[illegible]	[illegible] days.

[1] [illegible]

In the first series (tests 1 to 9), dosages of 1.5 and 2 per cent nicotine sulphate, in kaolin and in hydrated lime, were used. Examinations for curculio mortality were made daily. After 12 days 92.5 per cent of the beetles were alive in the cages containing the peach foliage and blossoms that had been dusted with nicotine sulphate. There was more feeding on the foliage and blossoms that had been dusted with the 1.5 per cent nicotine sulphate than on those that had been dusted with the 2 per cent strength. This may account for the greater mortality from the 1.5 per cent strength, the stronger nicotine dust probably having the greater repellent action.

In the other series (tests 10 to 17) 3 per cent nicotine sulphate in kaolin was dusted on peach foliage and fruit 1, 2, 3, and 4 times. Examinations for curculio mortality were made daily. The first dust was applied on April 11. All cages were closed April 26. The percentages of curculios that died from the treatments were as follows: Dusted once, 0; dusted twice, 30; dusted three times, 15; dusted four times, 40. The proportion of beetles that died in all cages was 22.5 per cent.

There was strong odor of nicotine in the cages immediately after dusting. On the following day the odor was still noticeable. A beetle was noted to be stupefied by the odor on that day but revived after being removed for several hours. On the second day after dusting there was a mild odor of nicotine in the cages, but on the third day it had entirely disappeared.

From these feeding tests one would conclude that nicotine sulphate is not an effective insecticide against the plum curculio.

CONOTRACHELUS ANAGLYPTICUS AS A PEACH PEST

Conotrachelus anaglypticus Say (pl. 10, C), a species of Curculionidae closely related to *C. nenuphar* Herbst (pl. 10, D), and referred to by Brooks and Cotton as the cambium curculio,[illegible] has been found to be a pest of the peach of some economic importance in Georgia. This curculio is much more active than the plum curculio and is somewhat smaller. It is reddish brown, whereas the plum curculio is grayish brown. When one becomes familiar with each species, no difficulty is experienced in distinguishing them.

On the morning of April 17, 1922, while jarring for the plum curculio in a peach orchard near Fort Valley, several adults of *C. anaglypticus* were taken from the jarring frames. Adults of this species were taken later several times during that season while jarring for *C. nenuphar*. The jarring for *C. nenuphar* was undertaken every other morning between 4.30 and 8.30 a. m. from the latter part of February until fall. *C. nenuphar* started to appear in the orchards during the middle of March, but the first *C. anaglypticus* did not appear until April 17. During May and early June, 1 *anaglypticus* to 100 or 150 *nenuphar* was collected from the frames, or an average of about 1 each morning.

When it was established that a few of the curculios appearing in the orchards from hibernation were *C. anaglypticus*, a number of curculio-infested peaches were collected in an orchard four weeks after the falling of the petals to determine if this species would attack sound peaches. From these peaches between 700 and 800 larvae emerged. These larvae were placed in pupation boxes, and of the adults that issued from the boxes 10 were *C. anaglypticus*.

[illegible] Brooks, F. E., and Cotton, R. T. [illegible] Jour. Agr. Research [illegible]

These 10 *anaglypticus* were confined in a battery jar and supplied with egg-free peaches every 48 hours. Pressure of the life-history work on *C. nenuphar* prevented the taking of many life-history records on *C. anaglypticus*. No copulation or incubation records were taken; however, a number of eggs were deposited and second-generation adults reared. Upon reaching maturity in the peach, each larva entered the soil and constructed a cell for pupation similar to the work of *C. nenuphar*. *C. anaglypticus* pupae resemble those of *C. nenuphar*, only they are a little smaller. The eggs are usually deposited singly in the peach and resemble those of *C. nenuphar*, being a little more yellowish. The larva, though a trifle smaller, resembles the larva of *C. nenuphar*. Definite information on the length of the life-history periods of one *C. anaglypticus* individual of the second generation in 1922 follows: Time spent in fruit as egg and larva, 17 days, left fruit on June 30, pupated July 7, transformed to adult July 14, and left the soil as an adult on July 19, 1922. This individual was the first beetle of the second generation of either *anaglypticus* or *nenuphar* to leave the soil in 1922. The second-generation adults of *C. anaglypticus* were placed together in a battery jar with peaches. They did a considerable amount of feeding, but deposited no third-generation eggs before they went into hibernation October 1.

On May 7, 1923, three *C. anaglypticus* adults were captured on jarring frames in an orchard while jarring for *C. nenuphar*. This was the first record of the appearance of this species in 1923. Other dates on which *C. anaglypticus* adults were captured in Georgia peach orchards in 1923 were May 10, 1; June 2, 1; June 5, 2; June 11, 5; June 14, 4.

These beetles were all placed in battery jars, and fresh egg-free peaches supplied at intervals of three to five days. Seven *C. anaglypticus* larvae emerged on June 10 from the peaches exposed to the adults from May 20 to 23; 7 emerged from these same peaches on June 25; 1 emerged on June 25 from the peaches exposed from May 23 to 28; and 1 on June 25 from the peaches exposed from June 5 to 10.

The first record in 1924 of the appearance of *C. anaglypticus* adults in the orchards was on April 22, when 6 beetles were captured in an orchard near Fort Valley where 111 *C. nenuphar* adults were captured during the jarring, so that 5.1 per cent of the adult curculios in that orchard on April 22, 1924, were *C. anaglypticus*. Other dates on which *C. anaglypticus* adults were captured during the 1924 season while jarring for *C. nenuphar* were as follows: April 30, 7; May 6, 8; May 13, 1; May 20, 3; May 27, 2; June 3, 3; June 18, 1; July 1, 1; July 15, 1; July 29, 1; August 5, 1.

The adults captured on July 29 and August 5 were probably second-generation adults, as they were clean and fresh and had the appearance of new beetles.

One incubation record on *C. anaglypticus* eggs shows that the eggs that were deposited on May 18, 1924, hatched in five days, the same incubation period as *C. nenuphar* eggs on the corresponding date. The first *C. anaglypticus* egg deposited by a beetle captured by jarring was laid on May 17. Other eggs were deposited by these adults as follows: May 18, 1; June 4, 1; July 10, 2.

Longevity records were taken on the *C. anaglypticus* adults that were captured by jarring in the orchard in 1924. Mortality observations were made daily, and the longevity period was found to be about the same as that of *C. nenuphar*. All of the adults that were captured in the orchard during April, May, and June died before the hibernation season. The three that were captured during July were alive on August 5. They were in all probability adults of the first or second generation of 1924, and probably entered hibernation during the fall. The adult captured on August 5 was a new beetle and in all probability an individual of the second 1924 generation.

Peaches that are infested with *C. anaglypticus* larvae fall to the ground during the April drop, as do those infested with *C. nenuphar*. First-generation *C. anaglypticus* adults were reared from peach drops collected in the orchards in April.

From the foregoing records and observations, it is obvious that the life history of *anaglypticus* in Georgia is very similar to that of *nenuphar*. Two generations of both species have been reared in a single season. Undoubtedly a small proportion of the "wormy" peaches each season in Georgia is due to *anaglypticus*. Formerly all the wormy fruit in Georgia had been attributed to the work of *nenuphar*. These observations also definitely establish the fact that *C. anaglypticus* injures sound peaches. The peaches which were exposed to the first-generation adults of *C. anaglypticus* for the 2-day periods in 1922 and in which eggs were deposited were all sound and properly matured to that period in their development and were free from signs of any egg-laying or feeding punctures.

SUMMARY

Investigation of the life history and habits of the plum curculio in the Georgia peach belt were conducted during the seasons of 1921 to 1924, inclusive.

The maximum number of eggs deposited by a single female plum curculio was 516. The average number of first-generation eggs deposited per individual per season was 64.64 and the average number of second-generation eggs deposited per individual per season was 40.21.

The incubation period of first-generation eggs during the four years ranged from 2 to 12 days, with averages ranging from 4.33 to 5.08 days. The period of incubation of second-generation eggs ranged from 2 to 7 days, with averages ranging from 2.94 to 3.18 days.

The time spent in the fruit by first-generation larvae ranged from 21.5 days for those entering in April to 12.4 days for those entering in July. Second-generation larvae reached maturity in 12.7 days during the period of June, July, and August.

The average time spent in the soil as larva, pupa, and adult was 34.16 days for the first generation and 30.43 days for the second generation.

The average time required for the first generation to complete its entire life cycle was 52.26 days, and the second generation required an average of 47.53 days to pass through its entire life cycle.

Weather conditions influence the rate of winter survival and the time of emergence of hibernating curculios.

The most important parasite of the plum curculio is *Triaspis curculionis* Fitch.

The abundance of curculios may be reduced by jarring the trees and destroying the beetles caught, gathering the peach drops and burying them with quicklime, and disking the soil during the pupation period.

Acid lead arsenate was found to be the most effective insecticide for the plum curculio.

ORGANIZATION OF THE
UNITED STATES DEPARTMENT OF AGRICULTURE

August 16, 1930

Secretary of Agriculture	Arthur M. Hyde.
Assistant Secretary	R. W. Dunlap.
Director of Scientific Work	A. F. Woods.
Director of Regulatory Work	Walter G. Campbell.
Director of Extension Work	C. W. Warburton.
Director of Personnel and Business Administration.	W. W. Stockberger.
Director of Information	M. S. Eisenhower.
Solicitor	E. L. Marshall.
Weather Bureau	Charles F. Marvin, *Chief.*
Bureau of Animal Industry	John R. Mohler, *Chief.*
Bureau of Dairy Industry	O. E. Reed, *Chief.*
Bureau of Plant Industry	William A. Taylor, *Chief.*
Forest Service	R. Y. Stuart, *Chief.*
Bureau of Chemistry and Soils	H. G. Knight, *Chief.*
Bureau of Entomology	C. L. Marlatt, *Chief.*
Bureau of Biological Survey	Paul G. Redington, *Chief.*
Bureau of Public Roads	Thomas H. MacDonald, *Chief.*
Bureau of Agricultural Economics	Nils A. Olsen, *Chief.*
Bureau of Home Economics	Louise Stanley, *Chief.*
Plant Quarantine and Control Administration	Lee A. Strong, *Chief.*
Grain Futures Administration	J. W. T. Duvel, *Chief.*
Food and Drug Administration	Walter G. Campbell, *Director of Regulatory Work, in Charge.*
Office of Experiment Stations	———, *Chief.*
Office of Cooperative Extension Work	C. B. Smith, *Chief.*
Library	Claribel R. Barnett, *Librarian.*

This bulletin is a contribution from

Bureau of Entomology	C. L. Marlatt, *Chief.*
Division of Deciduous-Fruit Insects	A. L. Quaintance, *Associate Chief of Bureau, in Charge.*

U. S. GOVERNMENT PRINTING OFFICE: 1930